SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1911.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1911.

GENERAL PHYSICS.

1068. ***New Type of Mercury Air-pump.*** **S. R. Williams.** (Amer. Journ. Sci. 32. pp. 13–16, July, 1911.)—Describes with diagram a new type of mercury pump constructed on the principle of the chain and bucket water-pump. The pump exhausts directly against atmospheric pressure, which is an advantage for many laboratory purposes, and Röntgen-ray vacua can be reached with it. An endless chain runs over five sprocket wheels, and to it are attached any desired number of buckets. This system is contained in a cast-iron base, two iron tubes (about 3 ft. long) which are slightly inclined to the vertical and connected at the top by a small chamber to which is attached the vessel to be exhausted. Mercury is poured into the cast-iron base until the lower part of the two tubes and a chamber in the base are filled. On driving the chain by means of gearing to one of the sprocket wheels the buckets carry mercury up one of the tubes, and as the buckets turn over at the top, this mercury runs down one or other of the tubes. The buckets carry air down the other tube; this air is imprisoned when the buckets reach the level of the mercury, and is allowed to escape when the buckets are turned mouth upwards within the cast-iron base. As the exhaustion advances the mercury rises higher and higher in the tubes until it stands almost at barometric height. There is no danger of damage if anything breaks, as the mercury simply runs out of the tubes into the reservoir. A. W.

1069. ***Tide-predicting Machine.*** **E. G. Fischer.** (Eng. News, 66. pp. 69–73, July 20, 1911.)—Describes, with photographs and diagrams, the machine recently made for the Coast and Geodetic Survey, U.S.A., for tide-predicting purposes. The instrument is similar in principle to the Ferrel machine used by the U.S. Coast and Geodetic Survey from 1882 to 1910, but has numerous improvements. It indicates, with only one setting of the components, not only the times of high and low waters, but also the heights at any instant; the height amplitudes are on a scale of ¼ in. to 1 ft.; it produces automatically, for purposes of record, in place of the duplicates of the printer's copy, a true tide curve for a length of one year, upon scales of 1 : 15 to 1 : 120, marked off into hour spaces of ⅛ in. per hour ; it provides for 37 components, and indicates all results numerically for direct copying upon the forms of the printer. The chain and pulley method is used for summing the harmonic series. For details the original paper should be consulted. The time required by one man for setting the machine varies, according to the number of components used, from about 2½ to 4 hours ; that for the prediction of one year's tides ready for the printer from about 8 to 15 hours. The degree of accuracy of the predictions was tested by setting the machine for two stations with tides of a nature most likely to reveal faults of design or construction. The stations selected were Aden and Hong-Kong. The number of components used in the first was 35 and in the latter 33. The machine was run through nearly a year before 24 hourly heights were read to hundredths of a foot. The comparison of these heights with those obtained by careful computation showed a max. difference of 0·02 ft. in the case of the Aden tide and 0·06 ft. in that of Hong-Kong. A. W.

1070. *Friction in making Records in Soot.* **C. Fleiss.** (Phys. Zeitschr. 12. pp. 391–398, May 15, 1911.)—Investigations were made on the friction in making records in soot from gas, petroleum, turpentine, and camphor. Two kinds of paper were used : glazed paper and smooth writing paper. It was found that the magnitude of the friction R was connected with the pressure p of the tracing-point by the equation $R = \tan \phi \times p\sqrt{(1 + 2a/p)}$. The most suitable combination is glazed paper with petroleum soot. The effect of vibration is considered : (i) Perpendicular to the registering surface. The frictional resistance decreases, for large oscillations of the tracing-point, with increase in the intensity of the vibration. The effect of the frictional resistance for small oscillations of the tracing-point, approximates more to a proportional damping of the velocity the stronger the vibration. The frequency of the vibration is without effect so long as it exceeds a certain value. (ii) Vibration parallel to the registering surface and to the direction of the registering motion. The effect of the friction of the tracing-point approximates more to a proportional damping of the velocity the greater the frequency and the intensity of the vibration. (iii) Vibration parallel to the registering surface and perpendicular to the direction of the registering motion is without effect. A. W.

1071. *The Elastic Properties of American Ingot Iron.* **E. L. Hancock.** (Eng. Record, 64. pp. 11–12, July 1, 1911.)—Shows the effect of overstrain on the new product known as American ingot iron. This is nearly pure iron. Chemical analysis of material tested showed that the material contained 99·86 per cent. of pure iron. The tests show that elastic limit is not lowered by overstrain, but that, on the contrary, it is appreciably raised. Subsequent rest and immersion in boiling water raises the elastic limit still higher. The modulus of elasticity was lowered, but there seemed to be a tendency to return to its original value when allowed to rest. Results of these tests are compared with those of various grades of steel, with the object of showing that the effect of overstrain in various grades of steel is quite different. C. A. M. S.

1072. *Influence of Work and Finishing Temperature on the Physical Properties of Steel.* **T. H. Johnson.** (Eng. News, 66. pp. 52–58, July 13, 1911.)—

The author has summarised graphically the results of a series of tests made at the Watertown Arsenal (U.S.A.) on the effects of different amounts of reduction under the hammer, and of finishing temperatures, on the mechanical properties of open-hearth steel. The ultimate strength, elongation, and contraction are apparently independent of the finishing temperature, but the elastic limit is so markedly dependent that a relatively low elastic limit compared with the ultimate stress indicates a high finishing temperature. Up to about 15 per cent. reduction under the hammer the ultimate strength increases markedly, but is only slightly affected by further work. The elastic limit increases, but with a diminishing rate; the contraction increases at a constant rate, while the elongation increases up to about 12 per cent. reduction under the hammer and then remains constant. F. C. A. H. L.

1073. *Production of Castings to withstand High Pressures.* **H. C. H. Carpenter** and **C. A. Edwards.** (Inst. Mech. Eng., Proc. 4. pp. 1597–1634; Discussion and Communications, pp. 1635–1660, Oct.–Dec., 1910. Mech. Eng. 26. pp. 791–793, Dec. 23; 838–842, Dec. 30, 1910; and 27, pp. 4–6, Jan. 6, 1911. Abstract. Engineering, 90. pp. 870–876; Discussion, pp. 852, 853, and 855, Dec. 23, 1910.)—The conditions under which castings of non-ferrous alloys capable of withstanding high pressures can be obtained have been worked out. Admiralty specifications demand that such alloys shall withstand hydraulic pressures of 6000 lbs. per sq. in., but the authors have tested their alloys at 14–20 tons per sq. in. Both chill cast and green sand cast cylinders 6 in. by 2½ in. were made, machined to 5¾ by 2¼ in., and bored so that the wall thickness was ¾ in. These hollow cylinders were then tested with a Petavel pump. An alloy of 85 per cent. Cu and 15 per cent. Sn, deoxidised with a little copper phosphide, was first tested, but while the chill castings showed an average bursting pressure of 18 tons per sq. in., the sand castings never exceeded 7 tons. On account of their small freezing interval, high tenacity and ductility, ease of preparation and resistance to corrosion, copper-aluminium alloys appear to be eminently suitable for this purpose. The 9 per cent. Al alloy, on account of its high ductility, stretched so that the valve leaked at 12–18 tons, but on tightening the valve the pressure could be raised to 18 tons. An 11 per cent. bronze, however, withstood 20 tons without leakage or bursting, even in the form of a green sand casting. Experiments were then made on an hydraulic valve block with a lug 2⅝ in. diam. × 2 in., a barrel 8½ in. × 2⅝ in. to 2 in. diam., and a base plate 5⅝ × 4 × ¾ in., but it was impossible to obtain sound castings in spite of the use of various fluxes and deoxidising agents. Subsequent experiments on valves without the base plate showed that the conditions for obtaining sound castings are: (1) The alloy must be poured slowly at not more than 80° C. above the beginning of solidification; (2) the metal should enter the mould at the lowest point, preferably from a sort of well at the bottom of the gate, and in large castings the use of risers is essential; (3) the sand must not be too damp. Under these conditions the authors succeeded in producing valve blocks of the above dimensions which withstood 17 tons per sq. in. without bursting about four times out of six. Service tests of two steam valves of a 10·5 per cent. bronze for seven months showed no deterioration. F. C. A. H. L.

1074. *Strength of Steel from Structural Shapes.* **E. L. Hancock.** (Eng. Record, 64. pp. 129–132, July 29, 1911. Paper read before the Amer. Soc. for Testing Materials.)—The paper reviews the work done by the author and others, which shows the variation of elastic limit of steel cut from different parts of profile of structural shapes. The following reasons are suggested: (1) Difference in chemical composition, (2) difference in amount of work done on material in rolling, (3) difference in finishing temperature of the metal in different parts of profile, (4) cold bending of the beams in straightening. The results of tests seem to show that the chemical composition of open-hearth beams is very uniform throughout the beam. The overstraining of structural shapes is said by the author to *lower* elastic limit of metal, but not permanently; the elastic limit returning to, and exceeding, the original value when the material is allowed to rest. C. A. M. S.

1075. *Tests on White Anti-friction Bearing Metals.* **C. A. M. Smith** and **H. J. Humphries.** (Inst. of Metals, Journ. 5. pp. 194–206; Discussion and Communications, pp. 207–211, 1911. Engineering, 91. pp. 171–172, Feb. 3, 1911. Eng. Rev. 24. pp. 165–170, March, 1911.)—An alloy of 83 per cent. Sn, 11 per cent. Sb, and 6 per cent. Cu, which closely approximates to Charpy's alloy combining low brittleness and high compressive strength, has been tested in conjunction with four of the Atlas Co.'s alloys, in which the tin is gradually replaced by lead. The tests applied were tensile, compression, hardness, bending and impact, while, in addition, the alloys were examined microscopically before and after straining. Compression tests were made on 1-in. cubes, and all the specimens began to yield gradually at 5 to 7 tons. Above this a "time effect" was very noticeable. This time effect was also noticed in the hardness test, so that a constant time of 1 min. was adopted for the application of the load during the tests. A study of the results reveals very little difference between the two alloys of highest tin-content. Microscopic examination shows that neither the Sn, Sb, nor the Cu_3Sn crystals are materially affected even under considerable pressure. It is hoped that a discussion of the results will reveal physical tests which can conveniently replace the tedious friction tests.

F. C. A. H. L.

1076. *Stresses produced by Force Fits.* **A. Morley.** (Engineering, 92. p. 201, Aug. 11, 1911.)—Shows how the thickness of the wall of a cast-iron hub, pressed on by hydraulic power on to a large dynamo shaft, with given force-fit allowances, in order to keep the bursting stress within a given limit, may be calculated. A chart shows very simply the variations in max. stress in a given hub when, in addition to nominal allowances, given tolerances are taken into account. It is made clear that in such work the stresses depend more upon the fit allowance than upon the thickness of metal in the hub, and that allowance and tolerance require careful attention. C. A. M. S.

1077. *The Old Essex Merrimac Chain Suspension Bridge in Newburyport, Mass., and Tests on its Wrought-iron Links after 100 Years' Service.* **A. P. Mills.** (The Cornell Civil Engineer, April, 1911. Eng. News, 66. pp. 129–132, Aug. 3, 1911. Abstract.)—This bridge was first thrown open to the public in 1810 and was closed in 1909. A number of links taken from the bridge on its demolition were tested. Three of highest tensile strength showed a crystalline fracture. Of five links showing lowest strength, three showed a fibrous, two a crystalline break. The tests of this Norway iron revealed the existence of 0·35 per cent. of copper. The crystalline fracture is believed to be primarily due to presence of copper, and probably the amount varied in different links. This theory is supported by the examination of links tested, which showed that the most badly corroded ones revealed a fibrous structure, while those with a coarsely crystalline fracture were remarkably free from corrosion. Freedom from corrosion is due to the presence of copper. C. A. M. S.

1078. *Destruction of Cement Mortars and Concrete through Expansion and Contraction.* **A. H. White.** (Eng. News, 66. pp. 26–30, July 6, 1911. Paper read before the Amer. Soc. for Testing Materials, Atlantic City, June–July, 1911.)—Change in volume of concrete due to temperature has been determined with considerable accuracy to be for unit length 0·0000055 per 1 deg. F. The author investigates other changes due to chemical processes of setting and hardening and other variations due to wetting and drying of concrete. A review of the literature on subject is followed by the statement that quantitative results on the effect of alternately wetting and drying concrete are entirely lacking, and the author also proceeds to assign reasons for the "curious laxness in the study of the properties of Portland cement, which, next to steel, is the world's most important building material." The experiments, detailed at length, were made in the University of Michigan. The following general conclusions were obtained: Concrete hardening in a moist place and remaining continually moist throughout its life, expands slightly, but the compression stress developed in the concrete is probably not large enough to be injurious. Concrete hardening in air and remaining continually dry contracts. The contraction is roughly twice as much as the expansion of concrete continually damp. This greater stress is harmful not only on account of its magnitude, but because it puts the concrete in tension where it is weakest; it introduces an error of unknown magnitude into the calculations of all reinforced beams; it is responsible for cracks in the top coat of interior cement floors. Fortunately most of the bad effects become evident within three months. Cement side-walks, pavements, and stuccos exposed to the weather, contract when they are dry and expand when they are wet. The richer the mixture is in cement, the greater is the volume change, so that there is a differential expansion between the top coat and base of side-walks which is often enough to split the two apart. The few experiments made tend to show that integral waterproofing compounds do not prevent or lessen changes in volume. The only safety seems to be in use of lean mixtures, when the volume change is slight.

C. A. M. S.

1079. *Measurement of Surface Tension by Cantor's Method.* **R. Magini.** (N. Cimento, 1. Ser. 6. pp. 462–483, June, 1911.)—Further experiments with Cantor's method [Abstract No. 1571 (1910)] show that equimolecular alcoholic solutions of the stereoisomers, maleic and fumaric acids, have the same surface tension, viz., 2·501 mgm./mm., and that the surface tension of absolute alcohol, between −112° and +18° C. is a linear function of the temperature, decreasing as the temperature rises, the temperature coefficient of the surface tension (ϵ) being 0·0026018. Taking the coefficient of expansion (γ) of alcohol as 0·00104139, the ratio $\epsilon/\gamma = 2{\cdot}49$, which agrees fairly well with the theoretical value 2·33. The molecular weight of alcohol, deduced from the equation $a(\mathrm{M}v)^{2/3} = \mathrm{K}(\theta - t)$ where a is the surface tension in dynes/cm., v is specific volume in cm.^{3}, θ the critical temperature, t the temperature of observation, and K the known constant of Eötvös, is 80·84 at +16°, and 98·06 at −112°. The influence of pure air on the surface tension of various liquids is well observed by this method, that of benzol increasing, and that of water, especially freshly distilled water, being reduced by at least 1 per cent., while that of alcohol is unaltered. Incidentally alcohol is found to form at about —160° a glassy non-crystalline mass, which, when rapidly warmed, becomes first a viscous liquid, and at a slightly higher temperature crystallises, the crystals subsequently melting at —112°. W. H. Si.

1080. *Expansion and Contraction of Concrete while Hardening.* **A. T. Goldbeck.** (Eng. Record, 64. p. 78, July 15, 1911. Paper read before the Amer. Soc. for Testing Materials.)—A series of measurements, made under the direction of L. W. Page in the laboratory of the Office of Public Roads, U.S. Department of Agriculture, to determine the amount of contraction of concrete mixtures. The specimens were 8 in. in cross-section and 5 ft. long, moulded as columns so that one end was absolutely free to expand and contract, due to any cause. Various proportions and consistencies were used; the materials entering the concrete mixtures were Old Dominion Portland cement, bank sand, and ¾-in. crusher run gneiss. Curves show that specimens which were allowed to dry out immediately after moulding began to shrink almost from the day they were made, although the very wet mixtures for the first few days showed a tendency toward slight expansion. The unit contraction of the oldest specimen of very dry mixture was 0·00052 in. at the age of 8 months. After that age the contraction is very small. C. A. M. S.

1081. *Formation of Stable Columns of Liquids.* **C. R. Darling.** (Nature, 86. p. 555, June 22, 1911.)—When 5–10 c.cm. of aceto-acetic ether are poured into a test-tube filled with water to about one-half the height of its hemispherical end, a column of curved outline is produced, stretched by its own weight, and hanging from the surface of the water. The shape of column varies with the diam. of the tube, water being in all cases displaced from the lower part of the vessel and bounding the sides of the column of heavier liquid. The column breaks at its narrowest part if the original layer of water is too deep, or when water is gradually poured into the tube after the column has formed. Aniline, *o*-toluidine, and butyl benzoate give similar results. The column may be projected on a screen by placing the test-tube in a flat-sided vessel and surrounding with water. W. H. Si.

1082. *Stream-line Motion in Curved Pipes.* **J. Eustice.** (Roy. Soc., Proc. Ser. A. 85. pp. 119–131, April 11, 1911.)—In a previous paper [Abstract No. 1193 (1910)] it was shown by the author that even a small curvature in the length of a cylindrical pipe affected the quantity of water flowing through the pipe. In an attempt to discover the cause of this departure from the law of flow in straight pipes, colour tests were employed with specially-made glass tubes, in which the stream motion could be traced by the introduction of coloured water through nozzles. Diagrams are given showing the flow for various curvatures and various diams. of the tubes under test. The experiments show that when water is flowing at low velocities in a straight tube of uniform bore, filaments of colour maintain their form and relative positions, but when entering upon a curved portion of a tube some of the filaments spread out into bands of colour and cross to the inner part of the tube, travelling round its section close to the walls. If the curvature is sufficiently large or the curve sufficiently long, all the filaments would be affected. Other experiments in U-tubes seem to suggest that slipping may take place concomitant with the surface flow at the walls of the curved part of the tube. A quantity of dye having been spread over the whole of the surface of the tube, when water was allowed to flow through the tube, even at extremely low velocities, the colour disappeared immediately from the outer wall of the bend, more slowly from the inner wall, and very slowly indeed from the straight part of the tube. It was also noticed that as the velocity of flow increased, there was an increase in curvature of the stream-lines. It is inferred that the resistance to flow along the tube walls from the outer to the inner wall does not vary as the velocity directly, as in the ordinary viscosity equation, but it varies as the nth power of the velocity, where n is greater than 1 and probably greater than 2. Although surface flow and viscous flow may exist together in a curved pipe, it was observed that in U-tubes and in angle pipes, whilst the filaments in the straight pipe, before reaching the walls of the bend, continued unbroken up to the usual critical velocity in a straight pipe, the filaments flowing through the straight pipe after leaving the bend, usually broke up at velocities much below the critical velocity. The surface flow which commenced in the bend generated vortices which persisted in the water flowing through the outlet straight part of the pipe. This shows that the effect of a pipe bend or of an angle is not only to increase the resistance to flow in the bend itself, but also to increase the resistance in the contiguous straight pipe after the water has left the bend. The experiments show that, where it is beneficial to break up the regular lines of flow in a pipe, a curved pipe is more effective than a straight one; *e.g.*, in a tubular boiler or in a condenser, curved pipes would be more efficient than straight ones. A. W.

1083. *Bodies Floating in a Free or a Forced Vortex.* **A. H. Gibson.** (Manchester Lit. and Phil. Soc., Mem. 55. No. 7. pp. 1–19, 1910–1911.)—In the series of experiments described an attempt has been made to determine how, in either a free or a forced vortex, the behaviour of the object depends upon (*a*) its size, the depth of immersion remaining constant; (*b*) the linear dimensions, in similar objects of the same specific gravity; (*c*) the depth of immersion, in bodies of the same cross-sectional area but of different specific gravities; (*d*) the position of the centre of gravity in non-homogeneous bodies of the same size and shape; (*e*) the shape of the body; (*f*) the intensity of the vortex action. Tables are given detailing the behaviour of the floating bodies used in typical cases of the experiments in each series. The following appear to be the main conclusions to be drawn from the free-vortex experiments: (i) Floating particles, whose dimensions are very small compared with those of the orifice, rotate in spiral paths, approaching with a constantly increasing velocity, and finally disappearing down the funnel of the vortex. The rate of approach of such particles is sensibly the same as that of the fluid itself. The lighter particles, however, show a distinct tendency to approach the centre more rapidly than those of a higher specific gravity. (ii) If of dimensions which are moderate compared with those of the vortex, the behaviour depends largely on the shape, size, weight, and the position of the centre of gravity of the object. In every case the latter rotates about its own axis, relative to the surrounding water, in the opposite direction to that of its revolution round the centre of the vortex. If introduced near the periphery of the vessel it usually approaches the centre, and may either settle down to rotate in seeming equilibrium at some definite radius, alternately approach and recede from the centre, or straightway disappear down the funnel. In the experiments on the forced vortex the same series of floats was used as in the free vortex, and the following conclusions may be drawn: (i) Small bodies approach the centre with a radial velocity which is greater the greater the radius of rotation and the intensity of the vortex. (ii) In homogeneous bodies of the same size and shape the heavier shows the less tendency to approach the centre. (iii) A non-homogeneous body of the same size, shape, and weight as a homogeneous body, shows a lesser tendency to approach the centre. If the centre of gravity of the non-homogeneous body is sufficiently low, the body works out to the outer edge of the vortex. (iv) The shape of the plane of flotation (round, square, or rectangular) has no effect on the behaviour of the object. This is, however, only true so long as the vortex is a true forced vortex, *i.e.*, has the velocity everywhere proportional to the radius. Any acceleration or retardation of the containing vessel causes a sensible modification of several of the phenomena. (v) In similar homogeneous bodies of the same specific gravity the smaller appear to show the greater tendency to approach the centre, although this effect is not strongly marked. Explanations of the results are given. A. W.

1084. *Effects of Water of different Densities above and below a Lock Gate.* **C. Harding.** (Eng. Record, 63. pp. 692–693, June 24, 1911.)—This question has especial reference to the lock gates of the Panama Canal. A difficulty was anticipated in that with the gates where there was fresh water on one side and salt water on the other, there would be an unbalanced pressure when the water on each side was at the same level. It was thought that this would seriously interfere with the machinery for manœuvring the gates. The position of the culvert from the lock side to the sea side appeared to affect the problem. Experiments were made with the following general results: (1) Under the conditions existing at the lowest locks of the Gatun and Miraflores flights there would be no tendency of the salt and fresh water to mix; (2) that the theory with reference to the effects of water of different densities on the two sides of the gates is correct; (3) that equilibrium of pressure cannot be produced on the two sides of the gate with two culverts at different elevations until the circulation developed has had time to make the waters on the two sides of the gate of the same density. For these reasons the idea of an auxiliary culvert was abandoned. The expedient finally adopted consists in prolonging the main culvert beyond the lower valve, and curving it upward so as to discharge through openings in a horizontal plane. C. A. M. S.

1085. *Viscosity of Emulsions.* **Bancelin.** (Comptes Rendus, 152. pp. 1382–1383, May 22, 1911.)—For the viscosity K' of an emulsion formed of a liquid of viscosity K, Einstein proposed the formula $K' = K(1 + \phi)$, where ϕ is the total volume of the suspended solid spheres in unit volume of the emulsion. The present author finds as the result of experiments that the viscosity of the emulsion increases with the volume of the suspended spheres faster than the above formula shows. As a mean result of experiments the following is suggested, $K' = K(1 + 2{\cdot}9\phi)$. This leads to a value of N in accord with J. Perrin's result. [See Abstracts Nos. 664 (1906) and 1244 (1911).] E. H. B.

1086. *Example of Dynamics on the Relativity Principle.* **M. Laue.** (Deutsch. Phys. Gesell., Verh. 13. 14. pp. 513–518, July 30, 1911. Ann. d.

Physik, 35. 8. pp. 524-542, July 11, 1911.)—It had previously been supposed that the equal perpendicular forces at the ends of a bent lever with equal arms at right angles would balance it at rest, and that the changes in the arms and the forces in a moving system would be such as to still give a zero moment. This gives for the ratio of the forces in the moving system $\sqrt{(1-\beta^2)}$, where β is the ratio of speed of system to that of light. The present author shows that this conclusion is erroneous; that the ratio of the forces is the inverse of the above; and that the moment of the forces in the moving system, instead of vanishing, is β^2 times that of one of the forces in the resting system. It is pointed out that this is simply one example of the theorem that an elastic stressed body in pure translatory motion needs a moment equal to the rate of change of the rotatory-impulse (*Drehimpuls*).

E. H. B.

1087. *Some Old and New Physical Problems.* **H. A. Lorentz.** (Phys. Zeitschr. 11. pp. 1234-1257, Dec. 15, 1910. Paper read before the 82. Deutsch. Naturforscherversamml., Königsberg.)—After brief references to the earlier developments of ether theory the author develops his well-known equations based on the electron theory. According to these equations, which assume an absolutely motionless ether, neither density, nor elasticity, nor any mechanical properties could be ascribed to the ether, so J. J. Thomson's lines of force, Lodge's determination of ether density, and Bjerknes' and Korn's mechanical analogies would have to be rejected. Einstein's principle of relativity would remove the last trace of substantiality in the ether, its capacity of forming the basis of reference for a system of co-ordinates. An outline of this is given and shown to involve the rejection of Newton's law of action and reaction. Minkowski force is defined and compared with force in the Newtonian sense. The principle would also involve a transmission of gravitation with the speed of light. Observations on the eclipses of Jupiter's satellites would, it is shown, afford a criterion for determining its truth or untruth, but the numerical results obtained are not sufficiently reliable to provide the basis for a conclusion, though Burton's analysis of the Harvard observations is in accordance with the relativity principle. The only criterion other than these uncertain astronomical observations would be obtained from determinations of electronic mass. The validity of the relativity principle would remove the basis for the objection to Clausius' fundamental law of dynamics which gave rise to so much controversy in 1880. It is also shown not to be inconsistent with Liénard's observations on the ponderomotive forces on moving conductors, and the author asserts that the negative results of the Michelson-Morley experiment and of the attempts to obtain evidence of the double refraction arising from the motion of the earth can be accounted for only on the basis of the relativity principle. The author then passes to the consideration of the existing state of radiation theory, beginning with an outline of the theory of radiation from a black body. He then states that the main difficulty of the subject arises from the usual representation of the ether as a continuum, possessing, therefore, an infinite number of degrees of freedom which, he asserts, would lead to the manifestly impossible result that a ponderable body in equilibrium with the ether would be at the absolute zero of temperature, and therefore Hamilton's principle is inapplicable [J. H. Jeans's demonstration, see Abstract No. 1698 (1905)]; that equilibrium would only be attained after the lapse of an infinite time; and that after any finite interval the ratios of energies of ether and matter is finite, shows the impossibility to be only apparent, but leaves untouched the essential difficulty, the inapplicability of Hamilton's principle to radiation problems. Planck's theory of *resonators* is then discussed with Einstein's theory of *light quantums*, and the modifications of the latter by which Stark endeavoured to obviate the objections which in its original form appear to be insuperable. The author considers that the only radiation problem which can be considered as satisfactorily solved is that of phosphorescence as accounted for by Lenard, who suggests that the energy of the incident light increases the mutual energy of the molecule and its liberated electron, and that the subsequent radiation is due to vibrations in the molecule excited by the return of the electron. This theory is employed by Haas in conjunction with J. J. Thomson's hypothesis of the structure of the atom, but here again considerable difficulties are shown to be involved. The paper concludes with some applications of the methods of statistical mechanics to the development of Planck's *resonator* theory. G. W. de T.

1088. *Ascents of Registering Balloons in Russia.* **M. Rykatchew, Jr.** (Acad. Sci. St. Pétersbourg, Bull. 1910. Meteorolog. Zeitschr. 28. pp. 1–16, Jan., 1911.)—Analysis of the records obtained since 1902 with balloons sent up from Pawlowsk (latitude about 60°), Kutchino, near Moscow (lat. about 56°), and Nijni-Oltchedaew (Podolsk, lat. 48¼°). All the observations were made by the same method, and meteorographs of W. W. Kusnetzow were used throughout. The number of ascents from the three stations were 180, 47, 87; spoiled and lost records, and elimination of ascents which did not reach an altitude of 8 km., reduce the available numbers to 68, 32, 18. As regards the yearly mean temperature of the atmosphere on the surface and at higher levels, the difference between Pawlowsk and Kutchino increases up to an elevation of 8·5 km., decreases then, changes sign at 9 km., and attains its maximum of 4° at 12 km., P being first colder and finally warmer than K. The inversion stratum lies lower at P and highest at N, and the temperature in the isothermal stratum is highest at P and lowest at K. These features would be explained by the geographical positions of the three spots. With respect to seasonal changes, the inversion strata lie higher, by about 1 km., in summer (11 km. for P, 12 km. for K) than in winter; the temperature differences between spring and autumn are not large near the surface and at highest levels, and largest for the intermediate layers. The monthly changes at different levels are discussed with reference to A. Wagner's (Vienna) "Temperatures of the Free Atmosphere," 1909, in which book some of the Russian data are also considered. The maxima and minima occur on the whole later at higher levels, up to 9 or 10 km., than at lower levels, but may even be earlier at still greater elevation, especially about the solstices; it would thus appear that the highest strata (some observations extend up to 15 km.) are no longer influenced by the earth, and that their temperature depends merely on the sun and its position. The monthly seasonal changes in elevation of the inversion stratum seem to go together with those of the highest cirrus clouds, which are generally observed about 1 km. below the isothermal layer. The isothermal layer lies about 2 km. lower during cyclones than during anticyclones; but there was not sufficient material for the study of these features. Only temperatures are dealt with in this paper. H. B.

1089. *The Mechanism of Thunder Rains in the French Soudan.* **H. Hubert.** (Comptes Rendus, 152. pp. 1881–1884, June 26, 1911.)—It is a well-known fact that in West Africa, north of lat. 12° N., the rains come from the east, which is the more remarkable as this part of Central Africa is desert. During winter the prevailing surface wind in the region under discussion is an exceedingly dry north-easterly or easterly wind, known as the harmattan. This wind extends upwards at least to a height of 2000 m. After the commencement of spring this wind is no longer felt at the surface, but cloud observations show that it persists in the upper atmosphere; the height of its under surface is then, as a rule, at least 1000 m. At the surface the monsoon blowing from between south and south-west is the prevailing wind during this time of the year. From cloud observations its height seems rarely to exceed 800 m. Thus during the rainy season there are two superposed wind systems, the monsoon and the harmattan. The monsoon brings the moisture, but its precipitation in thunder rains is due to the interaction of these two currents. Thunderstorms only occur in regions and at times of the year when both these wind systems are in evidence, *i.e.*, in summer in the north of the area, and during the times of commencement and termination of the monsoon in the south. The summer rains in the south during the middle of the rainy season, when the harmattan is entirely suppressed, are not accompanied by thunder and lightning. Observations show that thunderstorms are propagated rectilinearly from East to West at the rate of about 60 to 75 km. per hour. R. G. K. L.

1090. *Thermal Properties of the Atmosphere.* **E. Schwoerer.** (Annal. Chim. Phys. 21. pp. 438–457, Dec., 1910.)—Assuming the atmosphere to be absolutely dry, it is shown mathematically that the temperature diminishes with increased height above the ground, according to the law—

$$T = T_0 - H/102{\cdot}6,$$

where T_0 and T are the absolute temperatures at the earth's surface, and at a height H, expressed in metres. Hence $H = 102{\cdot}6\ T_0[1 - (P/P_0)^{0{\cdot}2855}]$, and this equation, corrected for the moisture present, becomes—

$$\left\{1 + \frac{T_0}{110{\cdot}27(B_0 - \tau_0)\nu_0}\right\} \log T/T_0 - \frac{r_0}{258{\cdot}91(B_0 - \tau_0)\nu_0}$$
$$= 0{\cdot}2855 \log \frac{B - \tau}{B_0 - \tau_0} - \frac{r}{258{\cdot}91(B - \tau)\nu},$$

where B_0 and B are the barometric pressures, τ_0 and τ the vapour pressures at T_0 and T, and r the latent heat of vaporisation of water. These results have been confirmed experimentally, but do not apply when air saturated with moisture, and containing no excess of water, is subjected to increased pressure, or when the diminution in pressure causes the temperature to fall below 0° C., thus freezing the moisture, with formation of the light cirrus observed in the higher regions of the atmosphere. W. H. Si.

1091. *Ratio of Argon to Nitrogen in the Gases from Springs.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 152. pp. 1533–1535, May 29, 1911.)—Having shown that the volume-ratio (krypton)/(argon) is approximately constant in mixtures of natural gases [compare Abstracts No. 659 (1907) and 608 (1911)], the authors study the ratio (argon)/(nitrogen) in the gases from 52 French springs. This ratio, if multiplied by 100, is 1·18 for the atmosphere; in the natural gases it varies between 0·76 and 3·37, or, if the ratio in air is taken as unity (instead of 1·18), between 0·64 and 2·85; there is, however, only one case in which the ratio exceeds the value 1·7. Thus the ratio is fairly constant, while the ratio (argon)/(carbon dioxide) may have any value. It would appear, that this constancy is due to the inert character of the two gases, and that most of the nitrogen now found as gas must always have been in that state. The authors assume with A. Gautier, that these gases must essentially have come from the incandescent interior of the earth. By argon they understand the mixture of argon, krypton, and xenon. H. B

1092. *Earthquake Shock in the Lazial Hills, Italy, April* 10, 1911. **G. Agamennone.** (Accad. Lincei, Atti, 20. pp. 12–18, July 2, 1911.)—This was the first shock felt in Rome since the fairly sharp one of Aug. 31, 1909. About 10h. 44m. (a.m.) a shock, whose intensity on the "Mercalli" scale varied from III. to IV., was noted, especially in the higher parts of the town. From reports of shocks of intensity VI.–VII. felt in almost all the Castel Romano, Montecompatri, Marino, Albano, Ciampino, Frascati, and at the Geodynamical Observatory of Rocca di Papa, it was fairly evident that the seat of the disturbance was not far from these latter, to the NW. of the volcano Laziale. Shocks were felt as far north as Rieti (70 km.), Anagni to the east (45 km.), Anzio and Nettuno to the south (40 km.), and to the west as far as the sea-coast. The disturbed area extended for about 120 km. in greatest length, Sutri to Piperno (NW.–SE.), the breadth being about 60 km., whence, assuming an elliptic shape for this, its total superficies would be about 5700 sq. km. Almost immediately after the first shock a second was felt, and two smaller ones at 11h. 58m. and 13h. 24m. (=1h. 24m. p.m.), as well as numerous minor disturbances. Records were made by means of the seismographs at the Collegio Romano in Rome and at Rocca di Papa, and the author gives a reproduction of these. At the latter station the second shock occurred 1 second, at the former 3 seconds, after the first was recorded at each. The first of the later shocks was not observed at Rocca, and was hardly noted at most of the other stations; the second at all, and, in addition, at Tivoli (25 km. from Rome) and Genazzano (30 km.). According to the table of Zeissig, of Jugenheim Observatory, the position of the epicentre would be 10 km. from Rocca di Papa and 30 km. from Rome, corresponding to the relative retardation at these stations. Neither of the two points of intersection of the circles with radii thus determined giving satisfactory positions for this, the author, using the data obtained from the observations at Rome and Rocca, by a simple analytical method has attempted to find the epicentre otherwise. The problem being to some extent indeterminate, he has made a reasonable assumption, justified by the observed phenomena, and concludes that the position of the point is to the NW. of the volcano Laziale, being approximately on the same straight line with Rome and Rocca, at a distance of 6 km. from the latter, and consequently 18 km. from the former, between Marino and the railway station of Ciampino. He considers that the second shock, following immediately after the first, was due to the arrival of a somewhat slower-moving wave, whilst the difference in time of its arrival at the two stations was due to their varying distance, from the epicentre. In a future note he proposes to calculate the speeds of propagation of these two different seismic waves. F. W. H.

1093. *Rock Temperature in Long and Deeply Overlaid Tunnels.* **E. Lauchli.** (Eng. Record, 64. pp. 120–122, July 29, 1911.)—In this paper a study is made of the relation between geological structure and temperature, as given practical application in European tunnels. Next to the difficulties arising from the uncertainty of the materials expected to be penetrated in driving long tunnels, the rock temperature, no less than the amount of water to be taken care of, has become a problem of vital importance, as experienced recently while driving some of the long Alpine tunnels. Experiments carried on during the driving of the Mont Cenis tunnel had demonstrated that under mountains the increase in temperature of the ground was about 30 per cent. less than under valleys or flat land. Further observations had led to the belief that the cause of the variation in the geothermic gradient was due to the following reasons: (1) The profile or shape of the ground, as, for instance, mountains, peaks, valleys, or the existence of large bodies of water, such as oceans or lakes. (2) The existence of radio-active substances, or of substances able to give out heat by oxidation or otherwise. (3) The existence of volcanic substances, such as magmas. (4) The difference in the thermal conductivity of different materials. (5) The difference in the thermal conductivity across, or in the line of, the stratification. (6) The presence in the ground of flowing water. These are dealt with in detail. The results may be summarised thus: Under mountains the geothermic gradient varies in depth from 49 to 67 ft. per 1° F. For granites, limestones, and shales the gradient is 60 to 62 ft. per 1° F. For vertical or slightly inclined gneiss and schists of any kind it is 64 to 67 ft. For dry gneiss in horizontal layers it is 51 to 58 ft. For mica schists and sandstone the gradient is 44 to 49 ft. For wet rock it is about 8 per cent. greater. When the strata have a slope of somewhat less than 45° with the horizontal, the gradient is as follows: Dry gneiss, 55 ft.; phyllite, 58 ft.; mica schists, 51 to 58 ft. For wet rock it is about 5 per cent. greater. The factor of greatest importance, however, is the occurrence of water or springs. The large quantity of water met in the Bosruck tunnel caused the observed temperature to be 41 per cent. less than the expected temperature. It is therefore very important, when prognosticating the rock temperature to be encountered, to make a thorough study of the rainfall, the discharge of near-by streams, and the dampness of the ground, in order that the possibility of the occurrence of water in the strata penetrated may be to a certain extent determined. A. W.

1094. *Nature of Volcanic Action.* **R. A. Daly.** (Amer. Acad., Proc. 47. No. 3. pp. 47–122, June, 1911.)—An hypothesis is outlined proposing the assumption that the earth is exteriorly composed of successive shells of density, increasing with depth. Beneath the interrupted sedimentary shell is a continuous solid "granitic" shell, and, still deeper, an eruptive basaltic shell or substratum. It is supposed that all igneous action, since an early pre-Cambrian period, is the result of the mechanical intrusion of the substratum basalt into the overlying shell by abyssal injection. Dealing mainly with central eruptions as distinct from fissure eruptions, they are classified into two main groups: (*a*) principal, where each vent represents emanation from a main abyssal injection; (*b*) subordinate, where each vent originates over a magmatic body in the form of a laccolith, sheet, &c., which is satellitic with respect to a main abyssal injection. Principal volcanoes will be more active, of longer duration, more productive of lava flows, and more clearly related to crustal fissures. Kilauea is regarded as a subordinate volcano. The local occurrence of steam is not regarded as a primary cause of explosion, the energy for which is more probably derived from deep-seated heated magma. C. P. B.

1095. *Lunar Parallax Determinations—Greenwich and Cape of Good Hope Observatories.* (Roy. Astronom. Soc., M.N. 71. pp. 526–540, May, 1911.)—In 1904 it was arranged that, commencing with Jan., 1905, the crater Mosting A should be observed on the meridian at Greenwich and the Cape whenever practicable. The object was twofold—to give improved values of right ascension, and to obtain better values of the parallax. The number of days in each year when observations were obtained at both stations was about 20, so that the necessary 100 observations have occupied some 6 years in all. The observations are discussed in the present paper by A. C. D. Crommelin. C. P. B.

1096. *Mechanical Theory of Solar Corona.* **J. A. Miller.** (Astrophys. Journ. 33. pp. 303–329, May, 1911.)—The paper gives the results of an investigation of the streams of the 1905 solar corona, undertaken with the view of applying the mechanical theory outlined by Schaeberle in 1889. With a few slight modifications of the original assumptions, the main criteria were taken as considering the streams of the corona to be the projections, on a plane, of streams of particles, the motions of which are produced by ejection, modified by rotation of the sun, by its attraction, and by the pressure of its radiation. The tests were made by careful measurements of the curvatures of the streamers recorded on the Lick Observatory eclipse photographs. In many cases the actual forms observed were in very close agreement with those calculated from the theory. One notable feature is the persistence with which one edge, the convex one, of a streamer is sharply defined, while the other is diffuse. The calculations also agree with the actual photographs in showing that the further from the equator at which a streamer originates the larger will be the eccentricity of the orbits of the particles composing the stream. The shape of the streamers will be a function of the inclination of the sun's axis to the line of sight. C. P. B.

1097. *Magnetic Origin of Solar Prominences.* **H. Deslandres.** (Comptes Rendus, 152. pp. 1433–1439, May 29, 1911.)—In a previous communication the author has drawn attention to the association between prominences and the peculiar dark sinuous markings called *filaments* [Abstract No. 81 (1909)]. Also above these black filaments the vapours appear to be constantly rising, having a velocity of the same order as the linear velocity of rotation. If we then imagine an ion rising vertically with the gas of a filament, its path will be curved by the magnetic field. The velocity of the ion will not be modified, only its direction, and the resulting motion will be in the form of a spiral with axis parallel to the field. This would appear to explain the alternate positive and negative displacements often observed in high prominences. By calculation the field necessary to produce the observed phenomena is found to be very small, of the order of one-millionth the earth's magnetic field. (Ibid. pp. 1541–1554, June 6, 1911.)—A few further remarks are given on the variations which may be introduced by changes of sign of the charges carried by the ions. C. P. B.

1098. *Photographic Determination of Standard Star Places.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 71. pp. 416–438, March, 1911.)—Remarking that the original simplicity of transit circle determinations has been completely modified by the detection of numerous small but important errors, with the necessary means of correction or check, it is suggested that the time is now suitable for a portion at least of the fundamental constants to be determined from measurements of photographic records of star regions. For the differential observations of reference stars it is proposed to employ either a cœlostat mirror or some form of moving plate device, and then photograph, on the same plate, star regions of constant declination and differing in right ascension by some convenient quantity. For fundamental observations two telescopes adjusted at right angles to each other and pointing to the same mirror, might be used to photograph simultaneously two regions of the sky separated by 90° (affected by refraction). The various adjustments and corrections necessary are outlined. C. P. B.

1099. *Wave-length of Solar Line b_1.* **A. Perot and Mlle. Lindstedt.** (Comptes Rendus, 152. pp. 1367–1370, May 22, 1911.)—Measurements have been made of the variations of wave-length of the magnesium line b_1 at different points of the solar surface. By projecting an image of the sun 36 mm. diam. on a plate having a small aperture 3 mm. diam., small patches of the solar surface could be isolated and their spectra photographed. Every region thus observed was compared with a spectrum of a portion near the sun's centre. The results are given in the form of curves plotted with variations of wave-length as ordinates and distances of regions from centre of sun as abscissæ. The resulting displacements are different from those found for typical iron lines. C. P. B.

1100. *Spectrum of Nova Lacertæ.* **E. B. Frost.** (Astrophys. Journ. 33. pp. 410–417, June, 1911.)—Measurements of the star's position with the micrometer on the 40-in. Yerkes refractor confirm the statement that it is identical with a star shown on photographs of the same region obtained at various times in 1893, 1907, and 1909. Observed with the 40-in. telescope, focal peculiarities were experienced, as was the case with Nova Geminorum in 1903, a sharp crimson image being formed 9 mm. further from the objective than the usual image. Photographs of the spectrum have been obtained with a Zeiss doublet of 14·5 cm. aperture and 81·4 cm. focal length, in conjunction with an objective prism of 15° angles. The spectrum scale is 3·0 mm. from H_β to H_θ. The paper is illustrated by enlargements from three of these, taken on Jan. 23, 30, and Feb. 22, 1911, and also by one of the plates taken on a larger scale with the Bruce spectograph. A table of wave-lengths of lines found on the spectograms is given, the chief lines being those of hydrogen, and an unknown line near 4640. All are very broad with diffuse edges, rendering accurate measurement impossible. Additional spectograms obtained on May 4th and 6th show an increase in the intensity of the band near λ5000, probably indicating the transformation to the nebular spectrum, which is usual during the decline of new stars. C. P. B.

1101. *Radiation of Companion of Algol.* **J. Stebbins.** (Astrophys. Journ. 33. pp. 395–398, June, 1911.)—In a previous note [Abstract No. 208 (1911)] it was stated that the form of the light-curve between minima may be explained by assuming that the companion always presents one side to the primary, and is brighter on that side, either because of reflection, or because of the heating effect of Algol. The method introduced by Wilsing is employed for computing, by Lambert's law, the amount of light reflected to the earth by the companion. The albedo is found to be very high = 1·10. Nothing is at present known of the spectral type of the companion. C. P. B.

1102. *Variability of R. W. Cassiopeiæ.* **E. T. Whittaker and C. Martin.** (Roy. Astronom. Soc., M.N. 71. pp. 511–516, April, 1911.)—The variability of this star, R. W. Cassiopeiæ, was discovered by Madame Ceraski in 1905, and the period determined by Blakjo to be 14·80 days. In the present paper the light-curve is discussed from a series of 98 plates taken at the Dunsink Observatory with the 15-in. reflector between Sept. 1909, and March 1911, the magnitudes being determined from the diams. of the stellar images. Comparisons were made by making photographs of the cluster χ Persei on the same plate. The results are shown in a plotted curve, whose equation is also given. C. P. B.

1103. *Globular Star Clusters.* **H. C. Plummer.** (Roy. Astronom. Soc., M.N. 71. pp. 460–470, March, 1911.)—The problem of determining the law of distribution of stars in globular clusters is dependent on the counts of stars made either visually or from photographs, and hence is affected by the resolving power of the telescope employed, and also by the degree of precision with which the images have been held stationary on the plate during exposures. Pickering found some years ago: (1) that the law of distribution is essentially the same for different clusters; (2) the bright stars and the faint stars of a cluster obey the same law. Zeipel has compared the distribution in the clusters M_{13} and ω Centauri with the densities to be expected in a spherical mass of gas in isothermal equilibrium, and found that this represents the central parts of the cluster satisfactorily, but in the outer regions the cluster is less dense than the theory would indicate. The present discussion of the Harvard counts supports a similar view, and if the additional supposition is made that the cluster is the outcome of a nebula in convective equilibrium surrounding a central core in isothermal equilibrium, the discrepancy found by Zeipel for the outer regions may be to some extent explained. C. P. B.

1104. *Distribution of Spiral Nebulæ.* **A. R. Hinks.** (Roy. Astronom. Soc., M.N. 71. pp. 588–595, May, 1911.)—Dividing the known nebulæ into three classes: (A) Extensive irregular nebulæ such as Orion, all lying in or near the Milky Way, and presumably all gaseous; (B) small well-defined planetary nebulæ, probably all gaseous; (C) white nebulæ, giving continuous spectrum, and the majority of which are spirals. It is found that a large proportion of nebulæ belong to Class C. Taking the new evidence furnished by the Harvard Catalogue of "Bright Clusters and Nebulæ" by S. I. Bailey, the positions of all the objects were plotted on a special projection of the celestial sphere, with the galactic equator as the plane of symmetry. Inspection of the result shows decidedly that the spirals are not concentrated about the galactic poles, nor are they symmetrically distributed in galactic latitude. Specially made observations are wanted of the Magellanic Cloud nebulæ, to decide their true nature; at present no true spiral is known to exist among them. Counts are being made on the plates taken by Franklin Adams. C. P. B.

REFERENCES.

1105. *Direct Transformation of Expansion to Rotational Motion.* **L. Creux.** (Comptes Rendus, 152. pp. 1372–1374, May 22, 1911.)—Describes an arrangement of two equal and opposite spirals whereby, if fluid under pressure is introduced at the centre of the system at a constant rate, a couple is produced which is practically constant. A. W.

1106. *Portland Cement and the Question of its Aeration.* **H. K. G. Bamber.** (Inst. Civ. Engin., Proc. 183. pp. 85–109; Discussion and Communications, pp. 110–217, 1910–1911.)

1107. *Safe Load and Deflection of Helical Springs.* **R. G. T. Thomas.** (Engineer, 112. pp. 171–172, Aug. 18, 1911.)—The usual method employed is a laborious process of trial and error, involving squares, cubes, and fourth powers of inches and fractions of an inch. A series of graphs are shown by means of which can be found (1) safe load for a spring, having given the diam. of wire, the mean diam. of coils, and the shearing stress; (2) mean diam. of coils, having given the safe load, the shearing stress, and the size of wire; (3) the shearing stress, having given the safe load, diam. of wire, and mean diam. of coil. Various other easy calculations can be effected by aid of the graphs. C. A. M. S.

1108. *On Water Waves as Asymmetric Oscillations and on the Stability of Free Wave-trains.* **A. Stephenson.** (Phil. Mag. 21. pp. 773–777, June, 1911.)

1109. *Method of Demonstrating the two Fundamental Laws of Wave Propagation.* **A. G. Rossi.** (N. Cimento, 1. Ser. 6. pp. 287–306, April, 1911.)—A number of systems of pendulums, simple and elastic, are described by which the laws that (1) $v \propto 1/\sqrt{m}$ and (2) $v \propto \sqrt{f}$ may be practically demonstrated. W. H. Si.

1110. *Molecular Agitation in Viscous Fluids.* **J. Perrin and N. Bjerrum.** (Comptes Rendus, 152. pp. 1569–1571, June 6, 1911.)—The authors conclude that the laws of perfect gases remain applicable to emulsions whose viscosity exceeds a hundred times that of water. E. H. B.

1111. *Motion of Solid Bodies through Viscous Liquid.* **Rayleigh.** (Phil. Mag. 21. pp. 697–711, June, 1911.)

1112. *Relativity Principle and Forces between Moving Bodies.* **Lémeray.** (Comptes Rendus, 152. pp. 1465–1468, May 29, 1911.)—Taking the usual changes in the time, length, and mass, expressions are obtained for the forces between bodies in motion. (Errata, ibid. p. 1720.) E. H. B.

1113. *Relativity Principle.* **W. S. Franklin.** (Frank. Inst., Journ. 172. pp. 1–21, July, 1911.)—A lucid treatment on semi-popular lines and dealing with length, time, mass, &c. E. H. B.

1114. *Moving Gas on Relativity Theory.* **F. Jüttner.** (Ann. d. Physik, 35. 1. pp. 145–161, June 2, 1911.)—Mathematical discussion with special reference to an ideal monatomic gas. [See Abstract No. 848 (1911).] E. H. B.

1115. *Dynamics of Moving Systems.* **J. Ishiwara.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 5. pp. 81–89, May, 1911.)—Mathematical supplement to previous papers. [See Abstracts Nos. 149 and 150 (1911).] E. H. B.

1116. *Relativity and the Conservation of Momentum.* **N. Campbell.** (Phil. Mag. 21. pp. 626–630, May, 1911.)

1117. *On a Paradoxical Result from the Kinetic Theory of Gases.* **P. Gruner.** (Ann. d. Physik, 35. 2. pp. 381–388, June 29, 1911.)

1118. *Absorption of Light in Space.* **Innes.** (Transvaal Observatory Circ. No. 5. Nature, 85. pp. 453–454, Feb. 2, 1911. Abstract.)—Discussing the region of the sky surrounding *S. Corona Australis*, the author suggests that the apparent absence of stars may be due to the presence of an absorbing medium. C. P. B.

1119. *The Progressive Disclosure of the Entire Atmosphere of the Sun.* **H. Deslandres.** (Nature, 85. pp. 422–426, Jan. 26, and pp. 457–460, Feb. 2, 1911. Discourse delivered at the Royal Institution, June 10, 1910. In French.)

LIGHT.

1120. *Character of the Double-refraction of Liquid Crystals.* **D. Vorländer** and **M. E. Huth.** (Zeitschr. Phys. Chem. 75. 6. pp. 641–650, 1911.)—It is a remarkable fact that by far the larger number of liquid crystals show a positive double refraction. From the examination of about 100 cases the authors conclude that: (1) All the crystalline-liquid phases that have been examined (41 are quoted), which show neither pleochroism nor surface colours, have a positive double refraction, and that this is true even of 18 substances which contain an optically active radical (amyl esters, cholesteryl compounds, mandelates, &c.). (2) On the other hand, 18 substances which show pleochroism, surface colours, and circular polarisation (whether positive or negative) show a negative double refraction. Special interest attaches to substances which can exist in more than one liquid-crystalline phase. Two cases are quoted of substances giving three such phases, all transparent and all positive in their double refraction, and five cases are quoted in which two transparent positive phases are observed. In the case of ten substances one phase is transparent and positive and the other pleochroic, circularly polarising and negative. T. M. L.

1121. *Relationship between the Size of the Particle and the Colour of the Image.* **C. Jones.** (Photographic Journ. 51. pp. 159–172; Discussion, pp. 172–174, April, 1911.)—It is not unusual in photography to get a coloured image when the material that forms the image, if taken in bulk, has either no colour or a different colour. Thus coloured images can be produced in lantern slides from a silver emulsion by development only, so that presumably the image consists of silver particles, and silver itself has no colour. A gold print, made by coating one surface of the paper with ordinary gold chloride solution, drying it, and exposing it under a negative for one hour in the shade, may, if kept for some time in the dark, become purple or red, while the gold itself is yellow. Finely-divided Pt is obtained as a reddish-brown or sepia deposit in sepia platinum prints, and of any colour between this and a full black, though Pt has a colour very similar to lead. Amorphous carbon is black, but if very finely divided as in Indian ink and some other forms of lampblack, it may have a distinct brown or reddish tint. The material in these coloured substances is in a finely-divided condition, and the colour is often ascribed to the smallness of the particles, though the proof that it is due to this may not appear to be very direct. Experiment seems to show that it matters little, if anything at all, of what substance the particles consist. The idea as to the actual size of the particles that produce colour effects appears to be vague. Zsigmondy, finding by the concentration and counting method that the same colour may be associated with particles of different sizes, urges that the cause of colour must not be sought for in the sizes of the particles, but rather in the distances between them. The method employed in the present experiments is different from those of previous investigators. The particles are in gelatine films, therefore they do not move as particles in liquids do; the distance from one to another is unchangeable, therefore it is possible to measure it with accuracy. To do this the particles are simply enlarged by definite steps, the effect is noted, and the enlargement continued until they are of measurable size. Knowing the degree of enlargement, the calculation of the size of the original particle is easy. The silver particles are enlarged by adding mercury to them, and it is found that no difference is apparent between pure silver particles and particles containing more mercury than silver, if their size is the same. The mercury is added in definite proportions by treating the film containing the particles, first with mercuric chloride and then with ferrous oxalate; each treatment adds one atom of mercury to each atom of silver and of mercury present, so as to produce the series: Ag, $AgHg$, $AgHg_3$, $AgHg_7$, $AgHg_{15}$, &c. The method of production of the silver particles does not appear to affect the result. As the particles are enlarged the light that is lost (scattered, or perhaps partly absorbed) increases in wave-length. Granted that it is the size of the particles that governs the light effects in the direction stated, by getting still smaller particles there should be no colour—the light lost being in the ultra-violet. This is now proved to be the case. The results obtained also tend to indicate that the colour effects are independent of the nature of the material of the particles, and that it is the size of the particles which controls the colour effects is fully confirmed by measurements. Evidence is given to show that particles having a diam. equal to about ¼ wave-length produce very little if any effect on that wave, but that as soon as they bear a substantial proportion to the ¼ wave-length, the effect becomes considerable. Thus it is concluded that light is scattered by particles that approximate in diam. to half a wave-length of the scattered light. If this result is applied to the problem of the colour of the sky, it is found that if the particles present in the air, or between the earth and the sun, have diams. ranging up to a maximum of 0·12 to 0·13 μ the sky should be black, if the maximum ranges up to 0·15 to 0·17 μ the sky should be a pure rich blue, and the direct sunshine a little inclined towards yellowness. This condition would hold more or less up to a max. diam. of about 0·2 micron. If the largest particles range up to a maximum of about 0·22 to 0·28 micron the sky should become greenish and the sun's disc red. If still larger particles are present the colour of the sky should be diluted with white. It is interesting to note that according to O. Klotz the size of the particles able to move freely away from the earth as the result of light-pressure is exactly the size of the particles which, according to the above results, would give the bluest sky. In the *discussion*, **F. F. Renwick** stated that although agreeing in general with the author that the change of colour on development runs parallel with a steady increase in the size of the grain, he felt that the structure of the so-called grain itself was of importance in this connection. A. E. G.

1122. *Conflict of Visual Fields in the Stereoscope.* **A. Chauveau.** (Comptes Rendus, 152. pp. 659–665, March 13, 1911.)—Further experiments are described upon the effects of viewing unsymmetrical stereoscopic pictures when there is great inequality, natural or artificial, between the right and left eyes as regards acuteness of vision [see Abstract No. 867 (1911)]. The figures studied are simple geometrical diagrams, such as ground-plans of pyramids. The effect of relief is not affected by the inhibition exercised by the stronger eye upon the vision of the weaker. When the retinal pictures are symmetrical no inhibition occurs, however much the eyes differ in acuteness. A. E.

1123. *Measurement of the Intensities of the different Radiations of a Complex Radiation.* **H. Buisson** and **C. Fabry.** (Comptes Rendus, 152. pp. 1838–1841, June 26, 1911.)—The extreme refinement necessary in bolometric measurement of light which has been analysed by the spectroscope is a hindrance to investigation outside the infra-red region. In the new method the spectroscope is dispensed with; the intensity of the total radiation is measured after passage through absorbing media modifying each constituent radiation in a known degree. If A_1, A_2, &c., be the initial intensities of monochromatic radiations, z the thickness of the absorbing medium,

$$I = A_1 e^{-m_1 z} + A_2 e^{-m_2 z} + \dots$$

As many equations as desired can be obtained, either by taking different thicknesses z, or by employing different absorbents. Each coefficient m, relative to a simple radiation, can be got from preliminary measures in monochromatic light by ordinary photometric processes. In applying this method energy fluxes of considerable amount can be employed, and the bolometric apparatus need not be so sensitive as when the radiations are separated spectroscopically. The authors employ a thermopile connected with a galvanometer. Among the absorbents found useful are the following: solutions of potassium chromate, eosin, fuchsin, petrol, and quinine sulphate, also glass, and oxalic acid solution. A layer of water 2 cm. thick completely absorbs the infra-red rays from a mercury lamp without interfering with the other rays. Measures of the intensity of radiations from an Heraeus mercury lamp (length of quartz tube, 6 cm.; current, 8·5 amps. at 27 volts; power consumed in lamp, 95 watts) gave the following results, the intensity of the green ray being taken as unit :—

Total radiation (including infra-red	60	4858	0·88
Red	0·18	4046	0·64
5769 and 5790	0·49	Group 8660	0·41
5460	1·00	Group 8130	0·79
		2536	0·82

The total radiation of the lamp in all directions is calculated to be 85 watts; for the green line 5460 alone, 0·58 watt. The green and yellow radiations, which give nearly all the illumination, correspond to a radiating power of 0·9 watt. The difference between the 95 watts electrically furnished to the lamp, and the 85 watts of global radiation, represents the loss by convection in air.

A. E.

1124. *Radiation of Mercury Vapour Lamps.* **C. Fabry and H. Buisson.** (Comptes Rendus, 158. pp. 98–95, July 10, 1911.)—The radiations of various mercury vapour lamps have been analysed and compared by the method described in a preceding paper [see preceding Abstract], which enables the energy corresponding to different radiations to be evaluated in absolute units. The lamps examined were Heraeus, A.E.G., Westinghouse (ordinary), and Westinghouse immersed in water. The intensity and composition of the radiation varies greatly with the electric activity (watts consumed by the lamp) and conditions of cooling. The Heraeus lamp, which consumes 95 watts, radiates 0·9 in the form of green and yellow rays; the A.E.G., consuming 763 watts, radiates 39 in the green and yellow, which are the only rays of interest for purposes of illumination (the violet line only contributing 2 or 8 per cent. of the luminosity). For the chemical rays, of wave-length less than 8200, the following results were obtained :—

		Radiation.	
Lamp.	Consumption.	Total.	Ultra-violet.
Heraeus	95	85	0·81 watts
A.E.G.	768	85	86·2 ,,
Westinghouse	559	875	85·6 ,,
Westinghouse immersed	846	875	0·46 ,,

Thus, for every 100 watts furnished to the lamp, the Westinghouse emits 6· watts in ultra-violet, A.E.G. 4·7, Heraeus 0·85, and the immersed lamp only 0·18. The immersed lamp was designed for the sterilisation of water, with the idea of utilising its radiation more completely, and the above result shows that the result was poor economy. The Westinghouse lamp used was quite new, while the A.E.G. had been in action 600 hours. Some investigators have affirmed that mercury lamps cease to emit ultra-violet after a certain time, but the author's observations do not bear this out, though the point was not specially tested. A. E.

1125. *Detail in Photography.* **E. Goldberg.** (Zeitschr, Wiss. Phot. 9. pp. 313–323, June, 1911.)—There are three classes of detail: details of structure, details of colour, details of relative brightness. In monochromatic reproduction the last-named are the important factor; and in this sense a detail is a fine distinction between the brightnesses of two contiguous points in the picture. A difference smaller than ½ to 1 per cent. is indistinguishable. If the characteristic curve of the plate for the region in question slope at about 45°, all the detail in the original will be in the negative; if steeper than 45°, the negative will show more detail than was visible in the original; if flatter than 45°, less detail will be given; and all plates have curves which are flat for the shadows and the high lights. To determine the sensitiveness to differences of illumination for any given region, apparatus is described involving either (1) rotating sectors or (2) a pair of neutral grey wedges. It is impossible to deduce from the characteristic curve of the plate or paper the absolute degree of sensitiveness to differences of illumination, but the slope of the characteristic curve is proportional to this sensitiveness. The degree of sensitiveness is not a question of differentiation but of differences; since the curve is never continuous, but is made up of shorter or longer steps, which merge into a continuous curve only in an ideal grainless plate, but which produce abrupt differences in details in such material as carbon tissue. If the echelonated curves derived from different series of measurements be superposed and their outer angles joined, a thick hysteretic-diagram-looking curve will be obtained, the thickness of which at any level, measured horizontally, measures the degree of sensitiveness to differences of illumination. A. D.

1126. *Photography: Automatic Production of the Characteristic Curve.* **E. Goldberg, R. Luther, and E. Weigert.** (Zeitschr. wiss. Phot. 9. pp. 323–331, June, 1911.)—Hurter and Driffield's characteristic curve for different plates, &c. ($x = \log_{10}$ exposure $E = \log_{10} It$; $y =$ density or blackening $= \log_{10}$ opacity of negative), serves as a guide both to exposure and to subsequent treatment. In the methods used it is assumed that $E \propto t$ directly, which is not the case for the intermittent illumination used in the apparatus. The methods also assume that photometric opacity of the deposit is a measure of the photographic density, which is only the case when the deposit is of a pure grey. If we take a grey glass wedge, two measurements suffice to ascertain the density of this at any distance from the end. Print through this on a plate; develop and dry; lay the wedge across the resultant graded negative, and on looking through the whole the form of the characteristic curve of the plate will be seen as a locus of equal apparent opacities, the "isopake" curve, parallel to the characteristic curve. This combination can be printed through, so as to preserve a record of the form of the curve, in terms of photographic (not of photometrical) effect. Longer or shorter exposures affect the position of this curve, but not its form; a longer exposure sends it further up the axis of y. To get null-points, make one edge of the plate to be clear glass. The method can easily be made to give absolute measurements for the characteristic curve. The developed record shows a clear line of demarcation between a dark and a light region, the boundary of which is of the form of the characteristic curve; and this varies with the kind of plate and the mode of development. Papers as well as plates may be tested; print on them through the wedge, photograph the resultant, natural size, through the wedge laid across the dry plate in the dark slide. Since good grey glass wedges are not on the market, Goldberg has devised a method of making wedges, which will make $x \propto$ log exposure, out of gelatine. Publication of this method is promised. A. D.

1127. *Regularities in the Spectrum of Neon.* **H. E. Watson.** (Astrophys. Journ. 33. pp. 399–405, June, 1911. Cambridge Phil. Soc., Proc. 16. pp. 130–135, May 18, 1911.)—An extended examination has been made of the photographs of the neon spectrum [Abstract No. 74 (1904), 1794 (1908)] to determine if there be any evidence of series relationship among the lines, such as is known to exist for the lines of helium. About 321 lines have been measured, and their wave-lengths reduced to the corresponding oscillation-frequencies *in vacuo.* A considerable number of the lines have been arranged in sets of quadruplets and triplets, but there are several imperfections in the groupings. The whole spectrum appears to be divisible into three aggregations of lines, and the arrangement suggests the existence of a principal series and two subordinate ones. The system closely resembles that shown by the blue portion of the red argon spectrum as given by Rydberg. C. P. B.

1128. *Reversal and its Remedy.* **E. S. Shepherd.** (Photographic Journ. 51. pp. 249–254; Discussion pp. 254–257, July, 1911.)—This paper is the outcome of the work of W. H. Caldwell. In order to obtain a perfect negative upon an ordinary photographic plate, it is necessary that the exposure should be approximately correct within decidedly narrow limits, over-exposure resulting in a very flat image; still further exposure causing the reversal of the first effect of the action of light. When light acts upon certain salts of silver (for example, the halogen salts), it is generally accepted that a sub-salt of silver is produced, with the formation of a free substance such as chlorine, bromine, or iodine in the case of a halogen salt; but this action is at once arrested in the absence of an agent which will act as absorbent of the substance set free. The ideal absorber or sensitiser must be incapable of reduction in the light after its oxidation by the halogen set free, it must not reduce in the dark the silver salt employed, and it must absorb the halogen as rapidly as it is set free by light. Caldwell has found that all these properties are possessed by some salts of hydrazine, NH_2NH_2, and of hydroxylamine, NH_2OH. A sensitive surface having the above-mentioned properties can be prepared by using either one of the silver haloids alone, or a mixture of two or more of them in the ordinary way. To the finished emulsion the neutral salt of hydrazine is added. The amount of salt used is determined by the fact that one molecule of hydrazine hydrate is able to reduce four molecules of silver haloid. If the halogen set free by the action of light on a silver bromide film is effectually absorbed by hydrazine it should be possible to print out an image by the direct action of light upon the plate.

Experiment proves this to be true. A hydrazine plate, of course, shows no signs of reversal. In the *discussion,* **Shepherd** stated that the hydrazine added to the emulsion produces a very slight slowing action. Plates can be bathed in hydrazine solution after they are made, but it is better to introduce it in the emulsion-making. The addition of hydrazine does not affect the spectrum negative, and it can be used in combination with a dye for making a panchromatic plate, or added to a finished panchromatic emulsion.

A. E. G.

1129. *Ultra-violet Bands in Spectrum of Carbon Monoxide.* **P. Wolter.** (Zeitschr. wiss. Phot. 9, pp. 361–387, June, 1911.)—Previous work on the different carbon spectra by Deslandres, Loos, and others, is discussed at some length. Re-measurements of some of the bands were undertaken, and many new lines in these obtained. Various bands were carefully photographed and measured with the object of testing the series relations given by Deslandres. A large grating, 6·6 in. radius and 20,000 lines to the inch, was used, and the discharge was viewed end-on through a plane-parallel quartz plane sealed into the end of the tube containing the gas. The tube employed was similar to that used for steady currents by Konen and Jungjohann. The band starting at $\lambda = 2977$ was specially dealt with, about 860 lines being measured ranging to $\lambda = 2878$. The difficulty here in applying Deslandres' laws lies in the fact that the second differences are exceedingly small, and approximate to the max. possible errors, but it appears probable that Deslandres' first law is not sufficient to explain the structure of such a complicated band. The second law relating to the similarity of the series appears to hold for the first three series given, but the fourth series is so different that the law cannot, from the author's observations, be considered as verified.

A. W.

1130. *Ultra-violet Spectrum of Mercury Arc and Radiations which decompose Water.* **A. Tian.** (Comptes Rendus, 152. pp. 1483–1485, May 29, 1911.)—The light from a quartz mercury lamp rapidly decomposes oxygenated water, giving H_2O_2. The question arises as to which of the radiations from the lamp produces this decomposition. The experiments described show that the only rays which are effective in the decomposition are situated in the extreme ultra-violet, below wave-length 1900 Å, at which point the absorption curve for water rises sharply. Using a spectroscope with prism and lenses of fluorite, photographs of the lamp spectrum give a group of rays of wave-lengths 1846, 1848, 1851 Å., and a large triplet: 1941, 1971, 2000 Å. These lines have also been found, using other mercury lamps, and also in the spark between two globules of pure mercury. The rays with wave-lengths greater than 1941 Å do not produce decomposition of water, but the rays 1854, 1857·5, 1862 Å, given by the spark between Al electrodes, do produce decomposition. Thus, while oxygenated water is destroyed by ultra-violet light, which this liquid absorbs, but for which water itself is transparent, water is also decomposed, with formation of hydrogen and oxygenated water, in the ultra-violet region of the spectrum for which it is opaque.

A. W.

1131. *Wave-lengths of Lines in the Secondary Spectrum of Hydrogen.* **C. Porlezza and G. Norzi.** (Accad. Lincei, Atti, 20. pp. 819–828, June 5, 1911.)—A complete list is given of the wave-lengths and intensities of lines in the secondary spectrum of hydrogen, between the limits $\lambda = 6588·05$ and $\lambda = 3889·16$, measured by means of a grating having 10,000 lines per in., and a focus of 10 ft. In addition to the lines observed by Hasselberg and by Watson [Abstract No. 1244 (1909)] a large number of new lines have been discovered. **W. H. Si.**

1132. *Combustion Spectra of Hydrocarbons and of Metals.* **J. Meunier.** (Comptes Rendus, 152. pp. 1760–1762, June 19, 1911.)—From consideration of the conditions of combustion it is shown that the Swan spectrum does not depend exclusively on the hydrocarbons present in the flame, but also on the combustion itself, and is, moreover, intimately connected with the mechanism of the latter. Its production is confined to a small and well-defined part of the flame, and this shows that the reaction of combustion takes place altogether in this part of the flame. It is to be noted that oxygen, one of the factors of the phenomenon, does not show itself by any spectral line. Hydrogen in combustion behaves like the hydrocarbons. Magnesium ribbon gives, at the moment of combustion, splendid green bands shaded off towards the violet; that corresponding to the solar *b*, λ5172, is not so bright as another green band situated towards λ5000. Iron and Al give nothing worthy of note. Zinc burns with a blue flame, and gives a spectrum particularly good in the blue and violet without lines or bands. Cadmium shows a single persistent green line λ5879. Nickel gives a regular succession of bands shaded off towards the red, which seem to be periodic: a red band about λ6250; a green band, the most striking, about λ5540; other bands about λ5170 and λ5000. Cobalt, under the same experimental conditions, gives nothing. Copper gives bands not regularly disposed; the largest reaches from λ5800 to about λ5200. Lead gives numerous bands, very beautiful near the red. The spectrum of Bi is remarkable, giving an intermittent red line much less refrangible than the red Li line, and from λ6400 to λ5200 a succession of small regular bands, then a fine line λ4720; it is cut off sharply on the violet side, about the position of the solar G line. Antimony gives a green band, without a proper spectrum. Silver, under the same conditions, gives nothing. **A. W.**

1133. *A Case where the Emission and Absorption Spectrum may differ.* **T. Krawetz.** (Phys. Zeitschr. 12. pp. 510–511, June 15, 1911.)—Suppose the emitting molecule to consist of a motionless positive sphere with charge $2e$, and two electrons each of mass m and charge e. If no external forces act, the equation of motion for one electron is—

$$d^2x_1/dt^2 + k dx_1 dt + p_0^2x_1 - q^2x_2 = 0,$$

and that of the other a similar equation with x_1 and x_2 interchanged. On integrating, and neglecting k the damping, two values for the proper frequencies are obtained, viz., $\surd(p_0^2 + q^2)$ and $\surd(p_0^2 - q^2)$, corresponding to a doublet in the emission spectrum. Next, consider the dispersion of a medium consisting of such molecules. In place of 0 on the right-hand side of the equation, we have now $-eX/m$. If X varies periodically, reduction on the usual lines leads to Drude's expression for the dispersion of a medium with a single absorption band, with maximum at frequency $\surd(p_0^2 - q^2)$. Thus a line is absent in the absorption spectrum which was present in the emission spectrum. The same result is reached on taking the general case of several pairs of electrons. The peculiarity may be explained as follows, by the theory of a pair of equal systems. Of the two possible frequencies, only one exists when the two systems oscillate in the same phase, and only the other when they oscillate in opposite phases. In all other cases both frequencies occur. Now in free vibration either case is possible, but in forced vibration, since the molecular dimensions are small relative to the wave-length, the exciting forces on the two electrons are like. Hence their motions are like in phase, and therefore there is a single-period value. A. E.

1134. ***Magnetic separation of Spectrum Lines of Calcium and Strontium.*** **B. E. Moore.** (Astrophys. Journ. 33. pp. 385–394, June, 1911. Phys. Zeitschr. 12. pp. 443–445, June 1, 1911.)—Previous papers by other authors have included portions of these spectra [Abstracts Nos. 422 (1908), 107 (1910)]. The present observations were made with a 21½-ft. concave Rowland grating having 14,438 lines to the inch, and a magnet giving a field varying from 28,000 to 31,000 c.g.s. The separation of the various components is given in detail for the lines as divided into series. The conclusion is that the principal and subordinate series of doublets show the same uniform separation, both in magnitude of separation and in number of components, in all substances in which the types have been found. In calcium and strontium we have two other types of triplet series. From Preston's law we should expect not only that the lines in successive terms of the series should correspond, but also that there should be a similar agreement for the same series in passing from one substance to another. In the present cases there is a considerable divergence, the lines sometimes following Preston's law, but more frequently they fail to do so. C. P. B.

1135. *Air Spectrum given by Initial Spark Discharge.* **G. A. Hemsalech.** (Comptes Rendus, 152. pp. 1471–1474, May 29, 1911.)—In a previous note it has been shown [Abstract No. 519 (1905)] that the spectrum of the initial discharge of the self-induction spark differs from that emitted by the oscillations. The author has further shown [Abstract No. 878 (1907)] that the initial discharge is independent of the nature of the electrodes and that it is controlled by the capacity of these latter. This initial discharge is very rapid, for it is not possible to deviate it sensibly with a very strong current of air. The nature of the initial discharge undergoes notable variations; sometimes the positive bands of nitrogen predominate, at other times the first spectrum of the air lines. The present paper deals with the conditions of emission of these two spectra. The initial discharge was isolated by the air-current method, and the discharge conditions varied. When the spark-length was 8 mm., using a capacity of 0·0024 mfd. and self-induction 0·044 henry, the band spectrum predominated, the line spectrum being rather nebulous. If the spark-length is gradually increased, the nitrogen bands become weaker and even disappear, while the line spectrum is strengthened and finally it alone remains. With large capacities the initial discharge is feeble; as the capacity is diminished the discharge becomes more and more intense, and the bands and line spectrum increase together in intensity and almost in the same proportions. Increase of the self-induction also strengthens the initial discharge, so that for a given sparking distance the intensity of the spectrum of the initial discharge varies inversely as the capacity of the condenser and directly as the self-induction of the discharge circuit. Increase of the capacity of the electrodes produces a strengthening of the line spectrum, while the bands are weakened. Hence, the positive bands predominate when the capacity of the electrodes is small and the sparking distance small, *i.e.*, when the intensity of the discharge is small. The first line spectrum is developed, on the other hand, when the discharge is more intense. The line spectrum and the positive band spectrum are thus associated with the same electric condition of the air, and to pass from one to the other only needs a variation of the intensity of the discharge. A similar relation exists between the second line spectrum and the negative nitrogen bands; but in this case the essential condition is the existence between the electrodes of a layer of ionised air [Abstract No. 1018 (1911)]. The following table gives the origin and the conditions necessary for the production of the different spectra of nitrogen observed with the self-induction spark at atmospheric pressure:—

Nature of Spectrum.	Seat of Emission Centres.	Character of Discharge.	Electric State of Layer of Air before the Discharge.
First line spectrum ...	Initial discharge	Intense and rapid	Not ionised
Second line spectrum	Oscillations	Intense and rather rapid	Ionised
Positive bands (triplet series)	Initial discharge	Feeble and rapid	Not ionised
Negative bands	Oscillations	Intense and rather slow..............	Ionised

A. W.

1136. *Light in Simultaneous Electric and Magnetic Fields.* **P. Zeeman** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 2–11, June 28, 1911.)—After the discovery in 1896 of the influence of magnetic fields upon the radiation frequency the question as to whether electric fields could have a similar influence naturally arose. It is easily seen that an electric field alone gives a shift of the equilibrium position of the vibrating electron, but no change of frequency if the quasi-electric forces are proportional to the displacements. Ten years ago Voigt developed the consequences of the hypothesis that the simple law of proportionality is not followed by the restoring forces. He thus found that an electric change of frequency might be produced and proportional to the square of the electric field. But hitherto such an effect has not been experimentally observed. Two reasons are here given for this failure, viz., the smallness of the effect to be expected and the difficulty of maintaining an electric field across sodium vapour. According to Voigt's estimate the change of frequency in a field of 80,000 volts per cm. would hardly amount to one-thousandth part of the distance between the sodium lines. The theory of the combined influence of simultaneous electric and magnetic fields is now here developed. It is thus shown that though the electric field alone may produce no observable effect, yet it may modify the magnetic effects in a way permitting of experimental detection. These possible effects are illustrated by a number of diagrams, and it is hoped they may yet be realised. E. H. B.

1137. *The β-rays from the Active Deposit of Thorium.* **O. v. Baeyer, O. Hahn, and L. Meitner.** (Phys. Zeitschr. 12. pp. 278–279, April 15, 1911.)—The authors have followed up their work on the magnetic spectrum of β-rays from radio-active substances [Abstract No. 1710 (1910)], and find that in the case of a wire coated with thorium active deposit the spectrum consists of about 5 groups having velocities varying from 0·25 to 0·95 of the velocity of light. The homogeneity of β-rays before and after passage through matter has also been investigated and found to depend largely on their initial velocity. Rays with less than 80 per cent. of the velocity of light lose velocity appreciably on passing through very thin sheets of matter without becoming markedly unhomogeneous, while rays with greater velocities only suffer a small loss of velocity, but become unhomogeneous owing to production of secondary radiations. Thus all rays with more than 70 or 80 per cent. of the velocity of light are more or less unhomogeneous. Kathode rays of velocity less than 20 per cent. the velocity of light also become heterogeneous on passing through matter, and produce a large amount of secondary radiation; and curiously enough, it was observed that with β-rays the production of secondary radiation showed a minimum at mean velocities. The authors discuss the bearing of these results on the use of electroscopes for the determination of absorption curves of β-rays. E. M.

1138. *Radio-activity as a Kinetic Theory of a Fourth State of Matter.* **W. H. Bragg.** (Nature, 85. pp. 491–494, Feb. 9, 1911. Paper read before the Royal Institution, Jan. 27, 1911.)—The author's hypothesis that the γ- or Röntgen ray is not, as Stokes supposed, a spreading ether pulse, but "an electron which had assumed a cloak of darkness in the form of sufficient positive electricity to neutralise its charge" is here used as the basis for an attempt to construct a systematic theory of radio-activity. The spreading ether pulse would have insufficient energy to provide for that of the β-rays generated by it. The phenomena of secondary and tertiary radio-activity arising from α- and β-rays are most simply accounted for by representing the rays generally regarded as derived, as simple continuations of the paths of the original particles, which affords a satisfactory explanation of the comparatively high loss of energy in the case of α- and β-rays traversing thin plates of substances of comparatively small atomic weight. The author's hypothesis which makes the γ- or Röntgen rays corpuscular would lead to a kinetic theory of subatoms and electrons of exceedingly short life and extremely high velocities, so that with respect to them the kinetic system of molecules of a solid, liquid, or gas might be regarded as forming a practically stationary framework. G. W. DE T.

1139. *Amount of Radium contained in some Uranium Ores.* **W. Marckwald and A. S. Russell.** (Chem. News, 103. pp. 277–278, June 16, 1911.)—Recent experiments of Gleditsch, Soddy, and Pirret, and the authors have shown that the (Ra)/(Ur) ratio in minerals is constant except in the case of autunite [$Ca(UO_2)_2(PO_4)_2 + 8H_2O$], for which, however, the various investigators have found widely different values [Abstracts Nos. 1609, 1610 (1910)]. In the present experiments the ratio of ionium to Ur in the various minerals has been investigated, and while it was the same for Joachimstal and African pitchblende, yet, taking the ratios for these minerals as 100, the ratio for autunite had values between 76 and 98 for different specimens. These same specimens, however, gave (Ra)/(Ur) ratios which were much lower and showed much more variation. As ionium has a mean life of not less than 80,000 years, autunite must have an age of at least some hundred thousand years, and these experiments, in conjunction with the fact that autunite has a spongy structure as compared with the very dense oxides such as pitchblende and thorianite, point to the conclusion that the small He-content, (Ra)/(Ur) and (Pb)/(Ur) ratios must be due to the occlusion of the He and the partial extraction by water of the Ra and Pb from the mineral. This hypothesis was further confirmed by observations on rutherfordin (UO_2CO_3), the Pb-content and (Ra)/(Ur) ratio varying for different layers of the same piece of mineral. E. M.

1140. *A Variation in the Intensity of the Penetrating Radiation at the Earth's Surface.* **A. Thompson.** (Terrestrial Magnetism, 16. pp. 25–30, March, 1911. Paper read before the Amer. Physical Soc., Dec. 30, 1910.)—The paper deals with two remarkable increases in the ionisation in a closed vessel, observed at Toronto while Halley's comet was in the neighbourhood of the earth. An ionisation vessel of 30,000 c.cm. capacity was employed, and the normal ionisation current corresponded to the production of 30 ions per c.cm. per sec. However, the production of ions rose to from 100 to 130 per c.cm. per sec. on May 19, 1910 (1 p.m. to 4 p.m.), and May 21 (9.30 a.m. to 11 a.m.) (75th meridian mean time). Whether these unusual increases were due to the presence of the comet or not, appears to the author impossible to decide, but he considers that the effect was real and not due to faults of insulation, &c. The observations are interesting in conjunction with those of Wigand on the variation of the electrical conductivity of atmospheric air made at Halle on the same days [Abstract No. 1211 (1910)]. E. M.

1141. *Radio-activity of Gas from Thermal Spring at St. Saturnino, Sardinia.* **A. Bernini.** (N. Cimento, 1. Ser. 6. pp. 455–461, June, 1911.)—The spring on the right of the River Mannu emits 200 litres of water and 14 litres of gas per hour, the latter being radio-active. This activity, as measured with an Exner electroscope, increases during the first 3 hours in the electroscope, and then gradually diminishes. From the rate of its decay and of that of the activity induced in a piece of Al, the gas is concluded to contain RaEm. The slight radio-activity of the water is attributed to dissolved gas. W. H. Si.

1142. *Radio-active Tufa of Fiuggi.* **C. Porlezza** and **G. Norzi.** (Accad. Lincei, Atti, 20. pp. 985–989, June 18, 1911.)—Very small quantities of helium are occluded in the tufa of Fiuggi which, by Strutt's method [Abstract No. 1235 (1906)], are found to contain 5×10^{-10} per cent. Ra, and by analysis $0{\cdot}76 \times 10^{-8}$ per cent. U. W. H. Si.

1143. *Concentration of the Radio-active Emanation from Boracic Suffioni by Means of Carbon at Low Temperatures.* **C. Porlezza** and **G. Norzi.** (Accad. Lincei, Atti, 20. pp. 932–934, June 18, 1911.)—The radio-active gas from the Larderello suffioni has been passed through a U-tube containing carbon at 0° and various lower temperatures, and at −77° is found to be completely deprived of its activity, the emanation being absorbed. By this means the radio-active portion of the gas remaining after removal of CO_2 and H_2S can be further concentrated about 34 times, this then having a dispersion of about 68×10^4 volt-hours. The method is considered preferable to the use of liquid air. [Abstract No. 1875 (1905).] W. H. Si.

1144. *Secondary γ-Rays produced by β-Rays.* **J. A. Gray.** (Roy. Soc., Proc. Ser. A. 85. pp. 131–139, April 11, 1911.)—When the kathode rays in a vacuum tube impinge on any material, they produce Röntgen rays, and it might be expected that when the β-rays from a radio-active substance impinge on a plate, similar penetrating rays would be emitted from the plate, especially as such a penetrating type (the γ-rays) are almost invariably associated with the β-rays. Previous experiments by different observers [Abstract No. 924 (1908), &c.], however, have shown that in the case of the β-rays from RaC there is little or no evidence of the above phenomenon. The author has used for the present experiments the β-rays from RaE, which are known to be much less penetrating than those from RaC. The RaE, which was associated with RaD, was placed underneath an electroscope with a sheet of iron over it sufficiently thick to absorb all the β-rays so that the only radiation producing ionisation in the electroscope was γ-radiation. On placing sheets of different metals under the RaE the ionisation in the electroscope was considerably increased, and absorption and other experiments showed this to be due to γ-rays set up in the metal plates by the β-rays falling on them. The amount of secondary γ-radiation so produced was greater the greater the atomic weight of the material, and the experiments suggested that the whole of the γ-radiation from RaE might be secondary in nature. E. M.

REFERENCES.

1145. *Spherical Errors of Thin Lens System.* **J. P. C. Southall.** (Astrophys. Journ. 33. pp. 330–337, May, 1911.)—The problem considered is to find a system so proportioned that one or more of Seidel's five spherical errors may be eliminated. On account of the algebraical difficulties only thin lenses are considered. C. P. B.

1146. *Vector Analysis applied to Geometrical Optics.* **A. Sommerfeld** and **J. Runge.** (Ann. d. Physik, 35. 2. pp. 277–298, June 29, 1911.)

1147. *Circular Double Refraction of Chlorate of Sodium.* **G. Meslin.** (Comptes Rendus, 152. pp. 1666–1668, June 12, 1911.)—Describes experiments with a large crystal and the mercury arc lamp. E. H. B.

1148. *Form of Groove of Gratings.* **J. A. Anderson** and **C. M. Sparrow.** (Astrophys. Journ. 33. pp. 338–352, May, 1911.)

1149. *Röntgen-ray Photographs.* **Chanoz.** (Comptes Rendus, 152. pp. 1832–1834, June 26, 1911.)—A discussion of the action of Röntgen rays on bromide plates. [See Abstract No. 1615 (1908).] E. H. B.

1150. *On the Fogging Powerof Developers.* **C. E. K. Mees** and **C. W. Piper.** (Photographic Journ. 51. pp. 226–239; Discussion, pp. 239–241, June, 1911.)

1151. *Waves of Light Propagated in a Transparent Crystal.* **J. Boussinesq.** (Comptes Rendus, 152. pp. 1721–1726, June 19, 1911.)—Mathematical.

1152. *Resonance Spectra of Iodine Vapour.* **R. W. Wood.** (Phil. Mag. 21. pp. 261–265, Feb., 1911.)—[See Abstract No. 341 (1911).]

1153. *Heat Generated by Radio-active Substances.* **W. Duane.** (Amer. Journ. Sci. 31. pp. 257–268, April, 1911.)—A *résumé* of the experiments described in Abstracts Nos. 1073, 1409 (1909), and 1441, 1602 (1910).] E. M.

1154. *A Microscope Plate Micrometer.* **J. Zeleny** and **L. W. McKeehan.** (Phys. Rev. 32. pp. 530-532, May, 1911.)—Illustrated.

1155. *Theory of the Rainbow.* **W. Möbius.** (Ann. d. Physik, 33. 6. pp. 1493-1558, Dec. 20, 1910.)—A complete monograph on the subject. No brief abstract is possible. L. H. W.

1156. *Curvature of Spectral Lines from a Plane Grating.* **F. Biske.** (Ann. d. Physik, 34. 5. pp. 971-978, May 9, 1911.)—Describes the theoretical and experimental establishment of the curvature of these spectral lines. E. H. B.

1157. *The Coincidence Method for the Measurement of Wave-lengths.* **F. Papenfus.** (Zeitschr. wiss. Phot. 9. pp. 332-346, and pp. 349-360, June, 1911.)

1158. *The Psychology of Light.* **R. S. Woodworth.** (Amer. Illum. Engin. Soc., Trans. 6. pp. 437-467; Discussion, pp. 467-471, May, 1911.)

1159. *Speed of Röntgen Rays.* **J. Franck** and **R. Pohl.** (Ann. d. Physik, 34. 5. pp. 936-940, May 9, 1911.)—A discussion of the various modes in which it is possible to interpret the experiments of E. Marx on the above subject. [See Abstract No. 238 (1911).] E. H. B.

1160. *Ultra-violet Absorption Spectrum of Aniline.* **H. Koch.** (Zeitschr. wiss. Phot. 9. pp. 401-414, July, 1911.)—The original pages should be referred to for the tables and the photographs of the spectrum of aniline at different temperatures. L. H. W.

1161. *Radiant Matter.* **J. Joly.** (Roy. Dublin Soc., Proc. 13. pp. 73-87, June, 1911.)—A lecture dealing chiefly with the properties of the α-particle and the origin and nature of pleochroic halos. E. M.

1162. *Dynamical Nature of the Molecular Systems which Emit Banded Spectra.* **E. T. Whittaker.** (Roy. Soc., Proc. Ser. A. 85. pp. 262-270, June 9, 1911.)

1163. *Energy and Distribution of Scattered Röntgen Radiation.* **J. A. Crowther.** (Roy. Soc., Proc. Ser. A. 85. pp. 29-43, March 14, 1911.)—The full paper corresponding to Abstract No. 477 (1911).

1164. *Rubidium Radiation.* **E. Henriot.** (Comptes Rendus, 152. pp. 1384-1386, May 22, 1911.)—Examination of the various salts of rubidium shows the radiation to be proportional to the percentage of Rb present. [See Abstracts Nos. 646 (1909) and 559 (1910).] E. H. B.

1165. *Ratio between Uranium and Radium in Minerals.* II. **R[uth] Pirret** and **F. Soddy.** (Phil. Mag. 21. pp. 652-658, May, 1911.)—[See Abstract No. 1609 (1910).]

1166. *Association of Lead with Uranium in Rock-minerals: Application to Measurement of Geological Time.* **A. Holmes.** (Roy. Soc., Proc. Ser. A. 85. pp. 248-256, June 9, 1911.)

HEAT.

1167. *Coefficient of the Quadratic Term in the Formula for the Dilatation of Nickel Steel.* **C. E. Guillaume.** (Comptes Rendus, 152. pp. 1450–1453, May 29, 1911.)—The author's earlier researches on nickel steels have brought to light not only the singular behaviour of the dilatations of the intermediate alloys, but also the existence of a quadratic coefficient which varies from a negative value (conspicuous as the first example) to a positive value much greater than has been met with in other alloys. The low absolute value of the term, together with the fact that accurate measurements have only been made within a restricted interval of temperature renders its evaluation to a high degree of precision very difficult. An error of 1μ at 20° C. is sufficient to convert the normal positive value to a negative value very nearly equal to the quadratic term for the dilatation of Pt. [See also Abstract No. 498 (1911).]
F. C. A. H. L.

1168. *Melting-point of Tantalum.* **M. v. Pirani and A. R. Meyer.** (Deutsch. Phys. Gesell., Verh. 13. 14. pp. 540–551, July 30, 1911.)—The experimental difficulties and the problem of establishing a suitable temperature scale are first discussed. The melting-points of Au and Pd are used as standard temperatures. Full experimental details are given. As the result of these measurements it is concluded that the melting-point of Ta is 2850° C., and the possible error in this result is given as ±40°. A. E. G.

1169. *Heat Conductivity of Liquids.* **R. Goldschmidt.** (Phys. Zeitschr. 12. pp. 417–424, June 1, 1911.)—By means of a method based on that used by Schleiermacher for the measurement of heat conductivity in gases, the author has determined the heat conductivity of a number of liquids, the values of which are given only as provisional. The temperature coefficient of conductivity has also been determined and found to be negative; at room temperature it amounts to about 0·2 to 1·5 per cent. per degree. Molecular weight and constitution appear to have an appreciable influence on the heat conductivity. A. F.

1170. *New Method of Determining the Ratio of the Specific Heats of Vapours.* **A. Leduc.** (Comptes Rendus, 152. pp. 1752–1755, June 19, 1911.)—The extreme difficulty of determining this ratio experimentally is proved by the very discordant results published in Landolt's tables. The author has devised a simple method by means of which the ratio can be readily determined to an accuracy of 1 per cent. If p, T refer to a vapour at one pressure and temperature, and p', T$'$ refer to it at another, then, if it is compressed adiabatically and without condensation, we have $p'/p = (T'/T)^{\gamma/(\gamma-1)}$, where γ is the ratio to be measured. Taking the vapour through a certain thermodynamic cycle, and knowing the formulæ for the specific heat and the latent heat, an approximate equation is obtained from which γ can be found. Ether compressed from 100° C. to 20° C. gives $\gamma = 1{\cdot}06$, $L_1 = 77{\cdot}6$, $L_2 = 92{\cdot}1$, $p_1 = 485{\cdot}9$, $p_2 = 44{\cdot}24$, and $c = 0{\cdot}00195T$. Similarly for benzine (100° to 40°) $\gamma = 1{\cdot}12$; for chloroform (100° to 40°) $\gamma = 1{\cdot}186$; for acetone (100° to 20°) $\gamma = 1{\cdot}18$; for water (160° to 80°) $c = 0{\cdot}916 + 26 \times 10^{-4}T$, $\gamma = 1{\cdot}46$. A. R.

1171. *The Ratio of the Specific Heats of Vapours.* **A. Leduc.** (Comptes Rendus, 153. pp. 51–54, July 3, 1911.)—The author, in continuation of his previous paper [see preceding Abstract], finds the ratio, γ, of the two specific heats of a vapour for various temperatures and pressures. He obtains the following results :—

	Limits of Temp. C.	Limits of Pressure (Cm.).	*f*.	γ.
Water	150°—140°	299·5—271·8	1	1·365
	—	150 —136	½	1·336
	—	75·5— 68	¼	1·304
	140°—120°	180·7—149·1	1	1·337
	120°—100°	91 — 76	1	1·416
	100°— 80°	42·5— 35·5	1	1·465
Benzine	100°— 80°	127 — 75·4	1	1·135
Ether	50°— 40°	127·6— 76	1	1·075
	—	63·8— 36·9	½	1·066

stands for the fraction of saturation. A. R.

1172. *Ratio of the Thermal Expansion to the Specific Heat of Solid Elements.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 13. 11. pp. 426–430, June 15, 1911. Paper read before the Deutsch. Bunsen-Gesell., Kiel, May 27, 1911).—The author has shown previously [Abstracts Nos. 1114 (1908) and 1618 (1910)] that the ratio of thermal expansion to specific heat of the metals is, in the case of most metals, independent of the temperature. The author now shows that this follows from the Nernst theorem. If this theorem is valid it must follow from the above that change of specific heat and thermal expansion can be represented by the same temperature function. The author also draws certain conclusions from the Einstein theory of specific heat, *e.g.*, the ratio of thermal expansion to specific heat must yield the relative increase of proper frequency of the vibrating elementary systems with increasing pressure. Further, this relative change of proper frequency with pressure is about twice as great as the relative change of volume with pressure. These conclusions can, however, have only a restricted validity. A. F.

1173. *The Transition Temperatures of Sodium Chromate as Convenient Fixed Points in Thermometry.* **T. W. Richards** and **G. L. Kelley.** (Amer. Chem. Soc., Journ. 33. pp. 847–863, June, 1911. Amer. Acad., Proc. 47. No. 5. pp. 171–188, July, 1911.)—The authors recommend the use of sodium chromate hydrates as a means of verifying thermometers at three fixed temperatures in the neighbourhood of 20°. The chromate cannot be easily purified (from sulphate) by recrystallisation, but pure chromate can be obtained by starting with pure dichromate, almost neutralising this with sodium carbonate, drawing off the CO_2 by boiling, and then completing the neutralisation by pure sodium hydroxide. There are three hydrates: the transition point for deca- to hexa-hydrate is 19·525° on the international hydrogen scale, and for deca- to tetra-hydrate 19·987°. For hexa- to tetra-hydrate the transition point is 25·90°. The addition of sodium sulphate, which gives an isomorphous decahydrate, raises the temperature of the decahydrate-hexahydrate equilibrium. A. F.

1174. *Action of Light on Iodine Vapour.* **G. Owen** and **H. Pealing.** (Phil. Mag. 21. pp. 465–479, April, 1911.)—Solid CO_2 having been found to emit particles capable of acting as condensation nuclei, other subliming substances were tried [Abstract No. 1450 (1908)]. Camphor, naphthalene, benzoic acid, and iodine do not sublime in the form of particles sufficiently large to act as condensation nuclei for water-vapour; but when moist air or oxygen containing iodine vapour is illuminated, nuclei are produced possessing the following properties: The nuclei are very unstable, disappearing in a few seconds in the dark. They do not carry an electric charge. They are not obtained except in the presence of oxygen and water-vapour. They grow under the action of the light, but generally do not attain a size greater than that requiring a pressure-fall of 18·5 cm. in order to catch them. The light required for their production need not be very intense nor of a high degree of refrangibility. No nuclei are produced after the iodine has been in the apparatus for some days, but the equilibrium thus attained is destroyed by rinsing the glass walls of the apparatus with water. Glass-wool facilitates the formation of the nuclei, the number produced when iodine-laden air is admitted into the apparatus through a plug of glass-wool being much greater than the number obtained on placing iodine directly in the cloud-chamber. This property becomes less and less marked as the wool gets more and more saturated with the iodine. The action of the glass-wool is regarded either as being of a catalytic nature or as evidence of the wool being an unexpected source of contamination for the iodine vapour during its passage through it.

E. E. F.

1175. *Electrical Heating as a means of Prevention of Superheating of Liquids.* **J. H. Mathews.** (Amer. Electrochem. Soc., Trans. 19. pp. 81–90, 1911.)—The author has carried out experiments on the ebullioscopic method with a view to obtaining a knowledge of the different factors of importance for avoiding superheating. As compared with the method used by others, the authors' differs in the fact that the heating wire instead of being disposed in the form of a coil underneath the thermometer, is made in the form of a wide spiral which includes almost the whole of the liquid within its coils. This possesses the advantage that the vapour bubbles do not touch the thermometer but rise to the surface and produce efficient stirring of the liquid. The author also finds that comparatively thick wire (two strands of No. 26) through which a fairly heavy current is passed (7 to 10 amps.) gives rise to less superheating than when a thin wire is employed. The addition of beads is shown to be disadvantageous as they diminish the efficiency of the stirring by the vapour bubbles. The degree of superheating which occurs has been found to depend on the nature of the wire, to some extent, and on the condition of its surface. Nickel-chrome and "Advance" resistance wires have been found particularly effective; but with German silver wire considerable superheating may occur. This can be diminished, however, by roughening the surface of the wire.

A. F.

1176. *Equilibrium Temperatures in Fog Chambers.* **E. K. Chapman.** (Phys. Rev. 32. pp. 561–564, June, 1911.)—The first attempt to make a direct determination of the temperature existing the instant after expansion in a Wilson fog-chamber seems to have been made by R. A. Millikan in connection with work on the determination of *e*. He found that if the temperature fell at all to the theoretical value it returned almost instantly to room temperature. Further experiments by Millikan, Chapman, and Moody, showed that this exceedingly rapid rise in temperature after the expansion was due to the rapid inflow of heat from the metal electrodes. The present work was undertaken to determine if, in a fog-chamber in which such an inflow of heat was not possible, the actual equilibrium temperature reached in an expansion would agree with the value given by C. T. R. Wilson's method of computing this temperature. After making a correction to one of the vapour densities used in the final form of J. J. Thomson's equation for the temperature, the author finds the theoretical and experimentally observed values in complete accord. [See Abstract No. 411 (1910).] E. H. B.

1177. *A Physical Interpretation of Uncompensated Heat.* **L. Décombe.** (Comptes Rendus, 152. pp. 315–318, Feb. 6, 1911.)—According to the electron theory every deformation of a body may be expected to give rise to electrification, though this will not be sensible if there be no resulting orientation of the axes of the doublets so formed. Let $\pm dm_1$ be the charges developed in an element, of temperature T_1, of any system, then the charges may be expressed by equations of the form $dm_1 = A_1 dq_1 + A\, dq_2 + \ldots + M_1 dT_1$, &c., where A and M are in general functions of the parameters q and T which determine the state of the system, and of their first time derivatives. Now the heat production in dielectries in an alternating electric field is found to be proportional to the max. p.d.'s between the electrodes, so that the heat generated by the displacement currents follows the same law as in the case of conduction currents. The author calls the latter *Siemens Heat* from its first observer. [Monatsber. d. Berl. Akad., Oct., 1861.] If dq/dt and dT/dt are zero, as in a reversible transformation, the *Siemens Heat* represented by a sum of terms proportional to $A^2(dq/dt)^2$ and to $M^2(dT/dt)^2$, will also be zero. If conversely the *Siemens Heat* be null, then either none of the A and M are zero, and consequently all the dq/dt and dT/dt vanish, and the change is reversible; or some of the A or M are zero, in which case the corresponding values of dq/dt and dT/dt may be finite, when the change will be irreversible. In neither case is there electrification. Known thermodynamic results then tend to the conclusion that for changes unaccompanied by conduction, ionisation, or molecular disintegration the *Siemens Heat* appears or vanishes under exactly the same conditions as uncompensated heat, the irreversible changes unaccompanied by electrification being identical with the frictionless and non-viscous ones considered by Duhem and Amagat. Under these conditions, therefore, the uncompensated heat may be considered as *Siemens Heat*, and therefore essentially positive. G. W. de T.

1178. *A New Radiation Hypothesis.* **M. Planck.** (Deutsch. Phys. Gesell., Verh. 13. 3. pp. 138–148, Feb. 15, 1911.)—The author observes that his theory of finite elements of energy [Abstract No. 1284 (1901)] has proved of value in the investigation of a wide range of phenomena, but, as frequently pointed out, involves considerable difficulties, of which the principal one is its irreconcilability with the Maxwell-Hertz fundamental equations of electrodynamics. In the theory referred to the emission of the elements of energy is assumed to be excited by the continuous steady absorption of energy from the radiation incident upon one of the assumed oscillators. This the author now replaces by the assumption that the emission and absorption are entirely independent, the former taking place spontaneously in definite quantums of amount $\epsilon = h\nu$. The probability calculus then becomes applicable, and the probability of the emission of an element of energy by an oscillator of periodicity ν in a time dt which is small compared with the interval between two successive emissions will be $\eta n dt$, where η is a constant depending only on the nature of the oscillator, and n the number of elements ϵ originally contained in the oscillator. n will then be that positive integer, including zero, which makes the expression $U/\epsilon - n$ a positive real proper fraction, where U is the vibrational energy of the oscillator. The energy absorbed in the time dt can then no longer be equated to the energy emitted in the same interval, for the former varies continuously, the latter by jumps. Now if S be the entropy of the oscillator, and W the probability of its having the energy U, then it is known that $S/\log W = k$, where $k = 1{\cdot}346 \times 10^{-16}$ erg/degree. Then, T being the absolute temperature, it is shown that the new hypothesis gives for $\bar{U}$, the mean value of U,

$$\bar{U} = \frac{h\nu}{2}\frac{e^{h\nu/kT}+1}{e^{h\nu/kT}-1},$$

which differs from the value given by the earlier theory by the additive constant $h\nu/2$ replacing unity. For the high temperatures and considerable wave-lengths treated by Rayleigh and Jeans the old value of U will hold good, for the only modification introduced into the theory of black-body radiation is that for $T = 0$, the energy of the oscillator will be $h\nu/2$ instead of 0, and the effect of this will be inappreciable for high temperatures and long waves. Since the temperature equilibrium within a body depends on heat conduction as well as radiation, the new hypothesis involves the emission of energy in quantums only, in the case of corpuscular motions as well as radiation, *e.g.*, the energy of and rate of emission would depend only on the atom, the former on the periodicity of the vibration concerned, and the latter on its energy and electric charge. The hypothesis is therefore in agreement with the observed constancy of the emission velocity of the α-particles from a given atom, and with the recent results which appear to show that this holds good for the β-particles as well. The author suggests that it might also be the explanation of the free electrons in a metal making no sensible contribution to its specific heat, but he makes this suggestion with some hesitation since Drude's very different view that the energy of an electron is proportional to the absolute temperature, appears to be in close accordance with observation.

G. W. DE T.

1179. *Planck's Radiation Constant.* **A. Schidlof.** (Ann. d. Physik, 35. 1. pp. 90–100, June 2, 1911.)—A discussion as to the significance of Planck's radiation constant h. It is concluded that $h = 2\pi e\sqrt{Am/N^{1/3}}$, where e is the elementary charge, A the radius of the positive sphere, N the number of the charges, and m the mass of the electrons which vibrate inside a hydrogen atom. From this formula and the result of the dispersion measurements by C. and M. Cuthbertson, it is calculated that $h = 6{\cdot}05 \times 10^{-27}$. [See Abstracts Nos. 1562 (1905) and 1469 (1910).]

E. H. B.

1180. *Planck's Radiation Formula.* **P. Debye.** (Ann. d. Physik, 33. 6. pp. 1427–1434, Dec. 20, 1910.)—Though Planck's formula agrees with observation, his method of establishing it is unsatisfactory because the expression for the energy of a resonator is invalidated by the assumption of finite energy elements, so that the two stages by which the formula are derived are mutually inconsistent. The author dispenses therefore with the resonator altogether, and assumes merely the existence of the finite elements of energy, without attempting to determine whether they are to be regarded as determined by the ether or the matter. On this assumption only, and defining black-body radiation as that radiation which is the most probable of all possible types, he arrives at Planck's formula.

G. W. DE T.

1181. *Mechanical Foundation of Thermodynamics.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 804–817, Feb. 28, and pp. 858–865, March 28, 1911.)—The papers contain mathematical discussions of certain ensembles, and the author shows that they can be used to arrive at the properties of a real system because they are connected with the time ensemble and because the majority of their systems are equivalent. The importance of energy-space ensembles and also of the microcanonical ones is demonstrated. It is also shown that, under certain circumstances, the consideration even of canonical ensembles may lead to real physical conclusions.

G. W. DE T.

REFERENCES.

1182. *Specific Heats at Low Temperatures.* V. **W. Nernst** and **F. A. Lindemann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 22. pp. 494–501, 1911.)—This paper, the fifth of the series, deals with Cu, KCl, Al, Ag, Pb, and diamond. It is concluded that the Einstein formula for specific heat is confirmed and also the Planck radiation formula. [See Abstract No. 624 (1911).] E. H. B.

1183. *Theory of the Equation of State.* **C. Dieterici.** (Ann. d. Physik, 35. 2. pp. 220–242, June 29, 1911.)

SOUND.

1184. ***Resonance Frequency-Meters for* 1500 *Periods per Second.*** **R. Hartmann-Kempf.** (Phys. Zeitschr. 11. pp. 1183–1184, Dec. 8, 1910.)—By means of a modified construction it is now possible to obtain satisfactory indications with the vibrating tongues, up to 1500 periods per sec. The short tongues are given a bottle or "Indian club" shape and are soldered into the base. The neck or tongue vibrates in a hollowed space in the magnet pole to avoid its hitting the latter when it is strongly vibrated. The small indicating fans are dispensed with, and the tip and sides are painted white instead, which enables the vibrating tongue to be seen. L. H. W.

1185. *Absorption of Short Sound-waves.* **N. Neklepajev.** (Ann. d. Physik, 35. 1. pp. 175–181, June 2, 1911.)—Altberg failed to work with waves shorter than $\lambda = 1$ mm. [see Abstract No. 1045 (1907)] as the available energy diminished so rapidly with the wave-length. This was explained by P. Lebedew as due to the absorption of the energy in propagation. The present author then undertook an investigation of this absorption for waves between $\lambda_1 = 2{\cdot}5$ mm. and $\lambda_2 = 0{\cdot}8$ mm. The short sound-waves in air were produced, like those of Altberg, by an electric spark discharge from a condenser through an inductance. The diverging radiation was rendered parallel by a concave mirror, the parallel beam falling on a Fraunhofer diffraction grating of silver-steel rods. The first spectrum was used and concentrated by a second concave mirror on to an Altberg pressure apparatus read by a telescope and scale. The absorption with distance was ascertained by taking alternate readings with long and short distances between the grating and the source of sound. Putting J for the sound intensity, the results agreed with the expression $J_x = J_0 e^{-cx} = J_0 e^{-A_0 x/\lambda^2}$, where $A_0 = 0{\cdot}00078 \pm 0{\cdot}00005$.

E. H. B.

1186. *Shortest Sound-waves.* **P. Lebedew.** (Ann. d. Physik, 35. 1. pp. 171–174, June 2, 1911.)—Stokes showed in 1845 that in the propagation of a sound-wave the viscosity of the gas caused an attenuation so that the amplitude might be expressed by $u = u_0 e^{-mx}$ where $m = 8\pi^2\mu/3\lambda^2\rho a$, in which μ is the coefficient of viscosity, λ is the wave-length of the sound, a the speed of propagation and ρ the density of the gas. Kirchhoff in 1868 took into consideration the conductivity of the gas also and gave the expression $u = u_0 e^{-(m+w)x}$ where—

$$w = \frac{2\pi^2}{\lambda^2 \rho a} \cdot \frac{K}{C_p}\left(\frac{C_p}{C_v} - 1\right)$$

in which K is thermal conductivity of the gas, C_p the specific heat for pressure constant, and C_v that for volume constant. Jeans in 1904 treated the matter from the kinetic theory and took into account certain assumptions as to the constitution of the molecule. The effect of these corrections may be expressed as an increase of the viscosity coefficient, so that μ is replaced by $\mu' = 1{\cdot}146\,\mu$. We may now write for the intensity of the sound—

$$J = J_0 e^{-2(m+w)x} = J_0 e^{-Ax/\lambda^2}.$$

Then, for air at 18° C. and 758 mm., using the following numerical values in c.g.s. units from Landolt and Börnstein : $\mu = 0{\cdot}000185$, $\rho = 0{\cdot}00120$, $a = 34400$, $C_p = 0{\cdot}237$, $C_p/C_v = 1{\cdot}40$; and from G. W. Todd, $K = 0{\cdot}000058$, the author finds for Kirchhoff's formula $A = 0{\cdot}00032$, and for Jeans's correction $A' = 0{\cdot}00037$. The experimental value found by N. Neklepajev [see preceding Abstract] is $A_0 = 0{\cdot}00078 \pm 0{\cdot}00005$. So the latter is of the right order but of about double the value of the calculated constant. As this discrepancy lies outside the limits of experimental error the question is raised as to the validity of applying to sound-propagation constants whose values were obtained from statical experiments. As to the shortest waves possible, even supposing the value $A_0 = 0{\cdot}00078$ does not then increase, let l denote the distance in cm. corresponding to a decrease of the sound intensity to one-hundredth. Then we have—

for $\lambda_1 = 0{\cdot}8$ mm. $l_1 = 40$ cm.
„ $\lambda_2 = 0{\cdot}4$ mm. $l_2 = 10$ cm.
„ $\lambda_3 = 0{\cdot}2$ mm. $l_3 = 2{\cdot}5$ cm.
„ $\lambda_4 = 0{\cdot}1$ mm. $l_4 = 0{\cdot}6$ cm.

These indicate the limiting values for sound-waves in air. E. H. B.

1187. *String vibrating in Viscous Medium.* **J. E. Ives.** (Phil. Mag. 21. pp. 742–744, June, 1911.)—This paper develops an approximate theory of an elastic string vibrating, in its fundamental mode, in a viscous medium. The approximation consists in substituting for all the velocities, momenta, forces, &c., concerned, *mean* values for all these quantities. Thus the displacement q_x and velocity v_x of any point are given by—

$$q_x = q \sin (\pi x/l) \quad \text{and} \quad v_x = v \sin (\pi x/l)$$

where q and v refer to the middle point. Thus the mean velocity is $2v/\pi$ and the equivalent momentum of the whole string $2Mv/\pi$, where M is its mass. In the same way $2Rv/\pi$ is the mean frictional force, where R is the force which would be necessary to overcome the internal and external friction of the whole string if every point of it were moving with unit velocity. The period T is then given by $2/T = \sqrt{(\tau/Ml - R^2/4\pi^2M^2)}$, where τ is the tension of the string. E. H. B.

1188. *Dust Striations from Electric Spark.* **S. Marsh** and **W. H. Nottage.** (Phys. Soc., Proc. 23. pp. 264–275 ; Discussion, pp. 275–276, June 15, 1911.)—Following the experiments of T. J. Richmond and the theory of J. Robinson, the authors have carried out an elaborate series of experiments and developed a theory which is confirmed by them. The paper is illustrated by five photographs of the dust grains and figures. One shows the graduated fineness of the striations in the circular form as we recede from the centre, which is in accord with theory. Others show beautiful effects of reflection, &c., of the disturbance as it spreads among obstacles. [See Abstracts Nos. 1905 (1909), 185 and 1119 (1910).] E. H. B.

REFERENCE.

1189. *Photographs of Vibration Curves.* **C. V. Raman.** (Phil. Mag. 21. pp. 615–618, May, 1911.)—A set of photographs obtained from a special sonometer, each showing simultaneous vibration curves for string and sounding board which has, with the given arrangement, double the frequency of the string. [See Abstract No. 374 (1911).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1190. *Recent Electrical Theories.* **L. T. More.** (Phil. Mag. 21. pp. 196–218, Feb., 1911.)—The author advocates a modification of the electron theory in which Newtonian mass should be retained as fundamental and essentially invariable, and electric charges varying with the velocity should be accepted as an unexplained and unaccountable attribute of matter. We should then be able to continue to base our theories on purely mechanical laws, and to express all quantitative physical laws in terms of mechanical formulæ, which is of advantage so long as the measurement of physical quantities is ultimately a matter of measuring mechanical forces. He would like to see a stricter delimitation between the study of phenomena and inquiries into the causes of phenomena, physics being strictly confined to the former, and the latter relegated to the domain of metaphysics. "For example," he observes, "the principle of relativity is not strictly a physical law but the expression in mathematical symbols of the general philosophical law of the finite nature of the human mind which has been accepted for centuries. G. W. de T.

1191. *Positive Atomic Charges and Cohesion.* **F. Sanford.** (Phys. Rev. 32. pp. 512–517 and 518–521, May, 1911.)—Attempts to account for the differences of ionic velocities of positive ions by a specific difference in the charges, instead of the hydration of the ions. The charges, on this hypothesis, vary approximately as the square roots of the atomic weights. A further attempt is made to account for the different viscosities of gases on the basis of their positive atomic charges. E. E. F.

1192. *Lenz's Principle and Charging of Condensers.* **A. Leduc.** (Comptes Rendus, 152. pp. 313–315, Feb. 6, 1911.)—By means of formulæ derived from the investigations of Pellat and of Sacerdote the author shows that it would be incorrect to apply Lenz's principle to the effect on the capacity of a condenser of raising the potential of one of its coatings, to the extent of maintaining that the corresponding increase in the capacity involves changes tending to its increase in all the factors by which it is determined, directly and indirectly. It is only the immediate parameters K, S, *e*, that is to say, those which influence the capacity directly, which undergo such changes. For example, the temperature of the dielectric changes in such a manner as to oppose the increase in the capacity. G. W. de T.

1193. *On the Electrical Waves occurring in Nature.* **W. H. Eccles** and **H. M. Airey.** (Roy. Soc., Proc. Ser. A. 85. pp. 145–150, April 11, 1911.)—The authors, one in London and the other in Newcastle, listened at agreed times, generally about midnight, to the atmospherics which were heard in the telephones of their respective radiotelegraphic receiving stations. The results are set out in a table giving coincidences and percentage of coincidences; they are also discussed. The conclusion to be drawn is that between 60 and 80 per cent. of the atmospherics audible at Newcastle and London, about 270 miles apart, are due to the same cause. This cause is probably a discharge of atmospheric electricity at places whose distances from the stations are possibly of the order of several hundreds of miles. L. H. W.

1194. *Thunderbolts.* **W. M. Thornton.** (Phil. Mag. 21. pp. 630-634, May, 1911.)—The term thunderbolt is given in common use both to the rare phenomenon of ball lightning and to meteoric stones. In the latter case it only has meaning in so far as their luminous path resembles lightning or that they cause great atmospheric disturbance, and it is here used to describe the former. The singularity of ball lightning lies in the complete isolation of a gaseous sphere having no envelope, yet within which there is energy stored by previous electrical action. This is in the end liberated with explosive violence. From the scattered records of its appearance the following facts may be regarded as established: It is observed as a luminous blue ball, occurring after lightning flashes of great intensity, and either falling slowly from clouds or moving horizontally some feet above the earth's surface. It is seen more often at sea than on land. Ball lightning appears to move under gravitative action on a mass somewhat denser than air, or horizontally in a feeble air current or electric field of force. The features of its end are significant; the ball simply ceases to be, and an explosion wave travels outwards from the spots. In all cases its disappearance is followed by a strong smell of ozone. From the circumstances of its origin, it is clear that there can be nothing present in it but the gases of the atmosphere. All records agree that a thunderbolt is somewhat heavier than air, and the following facts indicate that thunderbolts consist mostly of ozone in active recombination: (1) Ozone is said to be observed in their dissipation. (2) Ozone is the only gas denser than air produced in quantity under electric stress in air, as distinct from streaming spark-discharge. (3) On reaching the earth thunderbolts are frequently deflected, and travel horizontally as if repelled. The earth's surface and ozone are both in general negatively charged. (4) The energy liberated on the transition of ozone to oxygen in the volume of the fireball is sufficient to account for the explosive violence with which it bursts. (5) The blue colour usually observed with it is associated with the sparkless electrical discharge in air which causes the production of ozone. It is also observed when oxygen and hydrogen combine explosively; when nitrogen is present the colour of the explosion flame is yellow. These considerations lead to the suggestion that the principal, though not perhaps the only constituent of thunderbolts, is an aggregation of ozone and partially dissociated oxygen, thrown off from a negatively-charged cloud by an electric surge after a heavy lightning discharge. A. E. G.

1195. *Atmospheric Electricity in the High Andes, Bolivia.* **W. Knoche.** (Phys. Zeitschr. 12. pp. 179-182, March 1, 1911.)—The observations were made during the months April to Sept., 1909, in the Andes of Quimza Cruz, on the plateau of Aguila, at an altitude of 5200 m., with an aspiration apparatus of Ebert (with Mache condenser) and dispersion apparatus of Elster and Geitel. They concern the positive and negative charges, their differences and quotients, the numbers of positive and negative ions per cm.^{3}, their specific velocities, the conductivities, the potential gradients, and the vertical currents. The static, mostly negative, charges of the instruments disturbed the measurements very much, especially when the atmosphere was hazy or smoky. The author received a severe shock when brushing a vicuña hide; garments of this wool are common in Bolivia, but are dreaded during thunderstorms. The electric conditions are abnormal in the Andes, as Koenigsberger observed in the Gran Cañon; the specific conductivity was high (up to 80), and changed in the course of the day, but the max. values were not observed when the sun was highest. The potential gradient varied between 20 and 155 volts/m., but there was no proportionality between gradient and conductivity; like the conductivity the vertical currents fluctuated very much. H. B.

1196. *Atmospheric Electricity over the Ocean.* **G. C. Simpson** and **C. S. Wright.** (Roy. Soc., Proc. Ser. A. 85. pp. 175–199, May 10, 1911.)—During the voyage of the Antarctic ship *Terra Nova* from England to New Zealand experiments were undertaken to investigate (i) the electrical potential gradient existing over the ocean, (ii) the quantity of the radio-active products in the air, (iii) the number of free ions over the ocean, (iv) the ionisation of the air in a closed vessel, with the object of determining the presence or absence of a penetrating radiation over the sea. For all the work a Wulf electroscope [Abstract No. 1087 (1907)] was used. (i) In investigating the potential gradient ionium was used instead of a water-dropper or a flame. During the whole voyage observations were made every few days to determine the sign of the potential gradient, and it was found to be, without exception, positive on fine days. The curves for the daily variation appear to show that the potential gradient over the ocean within 40° of the Equator has its chief maximum in the evening and its chief minimum soon after mid-day. The effect of rain was found to be the same on the sea as on the land. As the rain approached the potential gradient generally decreased, and during one period of steady rain negative potential-gradient was noted. When, however, the rain was associated with a squall, the potential gradient took on large values, which changed rapidly from one sign to the other just as it does during a thunderstorm on land. The value of the potential gradient over the South Atlantic and the South Indian Oceans, far away from land, is very similar to that over the land. (ii) Over the Atlantic in both hemispheres the emanation increases from latitude 40° towards the Equator, but in the equatorial region itself, *i.e.*, within 10° of the Equator, the emanation has a low value. A possible explanation of this is given. The radio-activity over the ocean is apparently independent of the wind velocity, and hence of the amount of broken water—the mean value with winds less than force 4 on the Beaufort scales was found to be exactly the same as with stronger winds. Also no relationship between the emanation and the amount of cloud could be traced. (iii) For the ionisation experiments the newest form of Ebert's instrument was employed. The mean values obtained from 85 complete measurements were $I_+ = 0{\cdot}87$ e.s. unit per m.^{3}, $I_- = 0{\cdot}81$ e.s. unit per m.^{3}, $q\,(= I_+/I_-) = 1{\cdot}21$. From 10° to 40° S. the ionisation increased and q decreased. Experiments on land have shown a marked increase of ionisation with increase of temperature; the experiments on the sea indicate the same with the exception of temperatures higher than 20° C. As the latter were only met with in the trade winds (10° to 27° S.) the burdening of the air with salt may have counterbalanced the effect of temperature. The numbers obtained over the land under somewhat similar conditions are considerably higher than those obtained over the ocean. There appears to be little doubt that the ionisation over the sea is less than that over the land under similar meteorological conditions. (iv) The results of the observations on natural ionisation are as follows: (*a*) No regular daily variation has been found over the sea. (*b*) A slight dependence of the natural ionisation upon barometric pressure has been observed, a high barometer giving a low value for n (the number of ions per c.cm. in the vessel due to RaC in the air). (*c*) The number of ions in a zinc cylinder due to penetrating radiation from the soil at Matjesfontein has been found to be 6. (*d*) It has been found that a considerable addition ($n = 8$) to the normal ionisation, as measured on the ship, may be contributed by radio-active products deposited on the ship, and due primarily to a high value for the radium-content of the air. (*e*) The lowest number of ions per c.cm. per sec. observed in a closed zinc cylinder of 27 litres' capacity over the sea is 4. A. W.

1197. *Electric Charges of Rain.* **A. Baldit.** (Comptes Rendus, 152. pp. 807–809, March 20, 1911.)—Observations on the electrification of rain were made at Puy-en-Velay during the months May to Oct., 1910, the object of the investigation being to determine the respective duration of positive and negative showers, and also the electric charges carried by them. Gerdien at Göttingen in 1902 confirmed the observations of Elster and Geitel giving preponderance to negative showers. More recent results by Simpson at Simla show a small excess in favour of positive showers. The present results, from nearly 8500 observations, show a decided preponderance of rain positively charged, the ratio of the number of 15-sec. intervals when the rain was positive to that when negative being 1·52. The ratio of the quantities of water in the two cases was 1·45, which is practically the same as the ratio of the durations. The electric charge brought per sec. per cm.^{2} was calculated, and was found to vary from 0·1 to $7·9 \times 10^{-15}$ amp./cm.^{2}. For the cases where this current was greater than $0·5 \times 10^{-15}$ amp./cm.^{2} there is a tendency for the positive currents to become relatively more frequent than the average, and *vice versâ*. The highest values of the current were associated with thunder rain. A. W.

DISCHARGE AND OSCILLATIONS.

1198. *Charges of Fog Particles.* **K. Przibram.** (Phys. Zeitschr. 12. pp. 260–261, April 1, 1911.)—The author agrees with Regener's contention [Abstract No. 536 (1911)] that values of the elementary charge apparently below that of an electron are attributable to disturbances produced by the wall charges of the condenser. New measurements with a condenser of more suitable dimensions on particles of phosphorus, caustic potash, and sulphur, not only cease to show any values below $4·5 \times 10^{-10}$, but the charges observed are more decidedly clustered about Millikan's value and its multiples. E. E. F.

1199. *Electrification by Röntgen Rays.* **C. Bedreag,** with note by **Hurmuzescu.** (Annal. Scientifiques de l'Univ. de Jassy, 7. pp. 58–77, May, 1911.)—The author has investigated the charge gained by a metal plate exposed to Röntgen rays. He finds that this charge is positive for all the metals employed, the potential acquired varying inversely as the square of the distance from the X-ray bulb. Different metals were found to acquire different potentials, the order being that of the atomic weight for light metals and the voltaic series for the heavier metals. These results are discussed theoretically. E. M.

1200. *Negative Electrons from Potassium and Sodium. Conductivity of K and Na Vapours.* **K. Fredenhagen.** (Phys. Zeitschr. 12. pp. 398-408, May 15, 1911.)—The emission of negative electrons from potassium and sodium when heated was investigated, and the influence of a vacuum on this effect determined. With a sufficiently high vacuum a definite saturation current is found, especially with Na, which current with increasing temperature increases according to an exponential function. As regards the supposed spontaneous conductivity of the vapours of Na and K, it is shown that this, at least for temperatures up to 350° C., must lie considerably below the limit of galvanometric demonstrability. [See also Abstract No. 1277 (1909)]. A. W.

1201. *Positive Potential of Aluminium as a Function of Wave-length of Incident Light.* **J. R. Wright.** (Phys. Rev. 33. pp. 43-52, July, 1911. Phys. Zeitschr. 12. pp. 338-343, May 1, 1911.)—The source of light employed was a powerful spark between electrodes of Zn, Cd, or Fe, these metals being found to give the best results. The light from the spark was passed through a spectroscope with quartz prism and lenses, a second slit (*s*) being introduced in place of the eyepiece. The Al plate was contained in an exhausted glass tube surrounded by an earthed metal chamber, and only the light from the slit *s* could reach it. A positive charge was given to the plate, and then ultra-violet light of definite wave-length was allowed to fall on it until the max. potential was reached; this was measured with a Dolezalek electrometer, allowance being made for the natural leak of the instrument. The results, which are tabulated and graphed, show that for the intense ultra-violet light employed the positive potential of Al varies from about 0·25 volt to about 14·2 volts over the range 2900 to 2000 Å. The connection between this relatively high positive potential and the wave-length of the incident light was determined, and it appears that the positive potential, in opposition to the results given by Ladenburg and Hull, shows a sharp maximum for wave-length 2166 Å. The use of light from a different source is without effect on either the value of the max. potential or its position in the spectrum. [See also Abstracts Nos. 1674 and 1891 (1907).] A. W.

1202. *Ionisation due to Phosphorus.* **A. Blanc.** (Comptes Rendus, 152. pp. 1170-1171, May 1, 1911.)—Phosphorised vaseline is prepared by dissolving phosphorus in CS_2 and mixing it with melted vaseline. The mixture is thinly spread over a brass plate, which forms one plate of a condenser, the other connecting with an electroscope. After about 15 hours the oxidation becomes slow and regular. Ions of both signs are produced, and on applying a field the vaseline becomes polarised. The production of ions is considerably accelerated by the presence of the electric field, and is accompanied by the appearance of thicker fumes. The current increases more rapidly with the voltage than is required by Ohm's law. But there is also a "fatigue" effect, which increases with the voltage. As the phosphorus evaporates the effect of the field decreases, and finally there is a distinct saturation current, indicating a distinct limit to the rate of formation of ions. These observations explain why phosphorus in large quantity shows no saturation current (Barus, Schmidt), whereas air passed over phosphorus does (Bloch). E. E. F.

1203. *Valency in Gaseous Ionisation.* **R. A. Millikan and H. Fletcher.** (Phil. Mag. 21. pp. 753-770, June, 1911.)—The work of Townsend [see

Abstract No. 662 (1908)] and of Franck and Westphal is discussed, and the conclusion is drawn that, although these observers have found that doubly-charged ions exist in gases ionised by Röntgen rays, there are such contradictions and uncertainties in their work as to leave the question still an open one. In gases ionised by other agencies than Röntgen rays no one has yet found any evidence for the existence of ions carrying more than a single charge. The method now adopted is to suspend a very small positively-charged drop of oil in the upper part of the field between two plates of a condenser, adjusting either the charge upon the drop or the field strength until the drop is nearly balanced. The positive ions are thrown to the upper plate practically at the instant of formation. When one of them strikes the drop it increases the positive charge upon it, and the amount of charge added by the ion to the drop can be computed from the observed change in the speed of the drop. As the result it is concluded that direct, unmistakable evidence is obtained that the act of ionisation of air-molecules by both primary and secondary Röntgen rays of widely varying degrees of hardness, as well as by β- and γ-rays, uniformly consists, under all conditions which have been investigated, in the detachment from a neutral molecule of one single elementary electrical charge. A. E. G.

1204. *Kathode Rays produced in the Interior of Incandescent Lamps* **L. Houllevigue.** (Comptes Rendus, 152. pp. 1846–1849, June 26, 1911.)—Some phenomena produced by a carbon filament in a highly exhausted vessel have been previously described [see Abstract No. 922 (1911)]. Those effects with the exception of the action due to a magnetic field, which was peculiar, appear to be due to the ionisation of the mercury vapour by electrons emanating from the filament. With the aid of an arrangement analogous to that employed for producing canal rays, a true pencil of radiations has since been obtained which obeys the electromagnetic laws in the same manner as kathode rays. The method of obtaining such a pencil, together with experimental results obtained by means of it, is now described. A. E. G.

1205. *Heat liberated by Absorption of Electrons.* **O. W. Richardson and H. L. Cooke.** (Phil. Mag. 21. pp. 404–410, April, 1911.)—Part of the heat developed in Pt by the impact of slowly-moving electrons is independent of the kinetic energy of the electrons [Abstract No. 1511 (1910)]. This result has now also been verified for Au, Ni, Cu, phosphor bronze, Pd, Ag, Al, and Fe. The effect is attributable to the difference of the potential energy of an electron inside and outside a conductor. The effect is of the same order of magnitude in all cases, the measured values ranging from about 4·5 to 7·5 volts. The values are influenced very considerably by the nature and state of the thermionic emitter. The true effect may possibly be independent of the metal receiving the electrons. The measured effect is not influenced by changes in the pressure of the residual gas in the apparatus, provided this be reasonably low. Under certain conditions, not yet completely determined, the thermionic emission from osmium becomes unstable; and there are two ranges of stability, one at low and the other at high temperatures. E. E. F.

1206. *Discharge of Positive Electricity from Hot Bodies.* **W. Wilson.** (Phil. Mag. 21. pp. 634–640, May, 1911.)—Garrett has described the effect of the presence of water in temporarily increasing the positive electrification produced by heating aluminium phosphate [Abstract No. 117 (1911)]. In the present paper, which is of a preliminary nature, a similar phenomenon is described. The experiments, which in the main consist of testing the influence of water upon the discharge of positive electricity from heated Pt, are conducted in air at atmospheric pressure, the air having been freed from dust and moisture. The following are the results obtained: The activity of Pt is not reduced by continued heating merely, but only under conditions which admit of a positive discharge from the metal. It is suggested that the loss of activity is therefore due to the diminution of the quantity of matter—carbon, CO, or whatever it may be—which emerges from the Pt in the form of positive ions at sufficiently high temperatures. The activity is greatly increased by heating the Pt in the presence of water. This effect is possibly due to the production of CO and hydrogen in the Pt or at its surface, and can be observed even when the Pt is heated in a dry atmosphere, provided it has been previously heated and allowed to cool in an atmosphere saturated with aqueous vapour. There is apparently no positive leak (or only a very small one) when aluminium phosphate is heated on a Nernst filament, and therefore it is suggested that the leak observed when that salt is heated on Pt is either mainly a leak from the Pt itself, or the latter plays an important *rôle* in its production. A. E. G.

1207. *Incandescent Lime Kathodes.* **R. S. Willows** and **T. Picton.** (Phys. Soc., Proc. 23. pp. 257–263; Discussion, p. 263, June, 1911.)—Wehnelt has shown that oxides of the alkaline earths emit a large number of negative ions when heated; if, therefore, such substances are used as kathodes of vacuum tubes, a discharge may be obtained with a p.d. as low as 80 volts. In one form or another such tubes have been suggested as oscillation valves for the rectification of small oscillatory currents. Their behaviour at starting is, however, more or less erratic, and they are further said to lose their efficiency with continued use. The present experiments are undertaken to investigate these points. The substance used, generally lime, is placed on a metal strip, Pt or Ni, the strip being electrically heated in a tube similar to that used for experiments on aluminium phosphate [see Abstract No. 117 (1911)]. It is joined to the negative pole of a suitable battery, which drives the negative ions on to a metal plate connected with a galvanometer, the other terminal of which is joined to the positive pole of the battery. The source of lime appears to be without influence on the results. The experiments are conducted at pressures of (1) 0·002 mm.; (2) pressures greater than 0·5 mm.; and (3) in flames at ordinary atmospheric pressure, and the following results are obtained: When lime is heated on Pt-foil, so far from showing fatigue, it actually increases in activity. With p.d.'s greater than the saturation voltage this increase may be nine-fold. At lower voltages a slow but steady increase up to 100 per cent. has been found. The steady activity falls when the lime is cold, the initial activity may, however, greatly increase. With Ni-foil, if the tube carries a heavy discharge, the current increases to a maximum and then decreases. A greatly increased activity is frequently shown after the lime has been cold for some hours. At the lower voltages the current shows the same general variations as when Pt is used. Great irregularity is frequently shown on starting the current in a tube that has not been used for some hours. The lime may be at 1000° C. and yet produce no appreciable current. At this stage the discharge is very sensitive to mechanical vibration. A discharge from a coil greatly increases the activity. In the *discussion*, in answer to **C. H. Lees**, **Willows** stated that he had examined the films with the microscope and found them to be very adherent to the platinum. It was impossible to render the Pt free again from the activity with which the lime endowed it. There is no connection between the activity and the quantity of electricity passed. The increase in activity is probably due to the lime diffusing into the Pt. A. E. G.

1208. *Discharge from Hot Lime.* **C. D. Child.** (Phys. Rev. 32. pp. 492–511, May, 1911.)—When the p.d. between the electrodes is increased the discharge in a vacuum from hot CaO passes through a critical condition, the current being very much greater after the critical point is passed and the discharge becoming luminous. It has been suggested by J. J. Thomson that this sudden change is caused by the molecules having been hit so often by the electrons that many of them are in a state of unstable equilibrium, and that when in this state but a small increase in the electric force is needed to cause ionisation. There are the following reasons for thinking that this is not the correct explanation. First, the scarcity of electrons present in the tube render such repeated collisions very improbable. Secondly, the p.d. necessary to cause this sudden change does not depend on the number of electrons passing through the tube, but does depend on the condition and temperature of the kathode. Third, an examination of the potential gradient through the tube leads us to believe that the sudden increase in current is caused by something other than an increase in the ionisation in the gas. Lastly, the appearance of the discharge indicates very plainly that the number of electrons streaming from the kathode increases enormously when the discharge becomes luminous, becoming in fact very noticeable streams of kathode rays. On the other hand, some ionisation of the gas appears to be necessary as is shown by the fact that, when the pressure of the gas is very low, the discharge from a wire coated with CaO to a small surrounding cylinder is much smaller than that to a large cylinder. The phenomena may be explained by assuming that ionisation is produced at the kathode by the bombardment of its surface by positive ions and that such ionisation occurs very much more easily with a very hot kathode than with one which is cold. E. E. F.

1209. *Ultra-violet Light from the Mercury Arc.* **A. L. Hughes.** (Phil. Mag. 21. pp. 393–404, April, 1911.)—The max. velocity of electrons emitted from a surface illuminated by ultra-violet light is proportional to the frequency of the light used, and this fact has been adduced in support of Planck's hypothesis concerning the atomic structure of energy. Hull [Abstract No. 1724 (1909)] found the law to hold down to λ1230. If it holds generally, it offers a new method of determining the wave-length of invisible radiations. The author uses it for finding the limits of the spectrum of the mercury arc and of the hydrogen spectrum. To avoid the opacity of quartz, the light was made to fall upon a plate introduced into the vacuum of the mercury lamp itself, the pressure having been found sufficiently low at some distance from the arc. The velocity of the electrons was measured by the potential required to stop the leak from the plate by means of a cage surrounding it. It was found that the spectrum of mercury extends to about λ1230, while that of hydrogen, which extends to λ1030, has relatively more energy in the short waves. A special experiment shows that the velocity of electrons due to one wave-length is independent of the presence of other wave-lengths in the beam of light. E. E. F.

1210. *A Chemically Active Modification of Nitrogen Produced by the Electric Discharge.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 85. pp. 219–229, May 10, 1911.)—The author has shown [Abstract No. 513 (1911)] that the luminosity of the contained air in vacuum tubes after the discharge is over is of the nature of a phosphorescent combustion, and is due to the mutual reaction of nitric oxide and ozone, each formed in the discharge. It has also been shown [Abstract No. 622 (1911)] that other phosphorescent combustions can be observed in ozone, notably of sulphur, H_2S, acetylene, and iodine. Some of these give continuous spectra, but the majority band spectra. In the first paper it was stated that, when working with the simple induction coil, pure nitrogen gives no afterglow, a fact frequently verified since. P. Lewis has, however, described an afterglow obtained in nitrogen when a jar discharge with spark-gap is used. This is now confirmed, and the method of examination previously described applied to it, with the result that it may be regarded as established: (1) That pure nitrogen, from whatever source, subjected to the jar discharge, undergoes some modification which causes it to glow for a short time after it has left the discharge. (2) The glow, which is emitted while the gas returns to its normal condition, is not affected by the removal of ions. It is weakened by heating, intensified by cooling. This seems to favour the view that it is due to the recombination of dissociated atoms. (3) The modified nitrogen acts on ordinary phosphorus, combining with it, and at the same time forming much red phosphorus. (4) It combines with sodium and also with mercury at a gentle heat, forming in the latter case an explosive compound, and in each case developing the line spectrum of the metal concerned. It also develops the line spectra of other metals, probably combining with them too. (5) It develops the band spectra of compounds when they are vaporised in it, giving, in many cases, spectra of substances too unstable to be examined at the temperature of the Bunsen flame. (6) It attacks nitric oxide with the formation, strangely enough, of nitrogen peroxide, a more oxidised substance. (7) It attacks acetylene and the halogen derivatives of organic radicals, setting free the halogen, where one is present, and combining with the carbon to form cyanogen. This is proved by the brilliant cyanogen spectrum produced and by direct chemical tests. The given spectroscopic data are general and preliminary. An accurate investigation of the various spectra by photographic methods is in progress. A. E. G.

1211. *Spark Discharge at very small Distances.* **E. H. Williams.** (Phys. Rev. 32. pp. 585–590, June, 1911.)—In a previous paper [see Abstract No. 1751 (1910)] the author proved that the electrode material has no effect on the sparking potential; he also showed that the nature of the discharge at microscopic distances is the same as for longer distances. In the present paper he gives the results of further investigations on the effect of the dielectric and the gaseous pressure on the sparking potential. It was found that the minimum sparking potential for hydrogen is 248 volts and for CO_2 425 volts. It is shown that the minimum potential is not affected by the gaseous pressure. The effect of radiations from spark discharges and the electric arc on the sparking potential is also investigated. The results show that the electric waves have an appreciable effect on it. A. R.

1212. *Discharge from an Electrified Point.* **A. M. Tyndall.** (Phil. Mag. 21. pp. 585–608, May, 1911.)—These experiments form a continuation of the work the results of which have been previously published by Chattock and Tyndall [see Abstracts Nos. 967 and 1482 (1910)]. A brief summary of the theories of point discharge originally suggested is given. This is followed by further experimental results which are divided into two groups:

(1) Experiments on the strength of the field at the surface of a point, and (2) experiments on the pressure of the electric wind. As the result of the measurements of the field at the surface of a discharging point it is suggested that some of the observed effects originally attributed to the action of unclustered ions are due to an emission of uncharged doublets during ionisation by positive ions. When extrapolated the curve of wind-pressure on a plate (p) and the distance between point and plate (Z) cuts the axis of Z at a positive value Z_c. Z_0 is independent of the field at the point surface and of the current. It is in general about 4 mm. in length, but is much greater in negative discharge in pure hydrogen. The effects in air are explained by the doublet theory, and in hydrogen by the view that the negative ions in that gas are, in the main, corpuscular in nature. The apparent velocities of the ions in air, as measured by the wind-pressure method, becomes greater as the current between point and plate increases. This is explained by the presence of a back discharge from the plate, which prevents the method from being applied with accuracy except when the current is small. Evidence is adduced in support of the view that the positive ion in pure hydrogen is a charged molecule. The amount of combination which point-discharge produces in hydrogen containing different percentages of oxygen and nitrogen, and the form of the wind-pressure curves in these mixtures, is discussed and explanations are offered. A. E. G.

1213. *Free Vibrations of a Lecher System.* **F. C. Blake** and **E[mma] A. Ruppersberg.** (Phys. Rev. 32. pp. 449–475, May, 1911. Paper read before the Amer. Physical Soc., Chicago, Nov. 26, 1910.)—It is here shown that it is possible to obtain on a set of parallel Lecher wires a system of free vibrations uncontaminated by oscillator influence except that of coupling. It was found that the unmodified theory fitted even the case of close coupling to a first approximation. The conditions for freedom from contamination were found to be two : the introduction of suitable air-gaps into the oscillator circuit and suitable water resistance between the induction coil and oscillator. The ratio between Lecher wire length and wave-length was found to be 2·07, and the difference between this value and the theoretical value 2·00 was shown to be due to an end-correction which is always present. E. H. B.

1214. *Vibrations of a Lecher System.* **F. C. Blake** and **C. Sheard.** (Phys. Rev. 32. pp. 533–560, June, 1911.)—The free vibrations of a Lecher system, using a Blondlot oscillator, were investigated by Blake and Ruppersberg [see preceding Abstract], and the present paper deals with a corresponding work but using a Lecher oscillator. The best set of free vibrations was obtained when the distance between the Lecher wires was 1·6 per cent. of their own length. The ratio of wave-length to wire length was found to vary with the coupling, ranging from 2·16 to 2·08, the last figure being in agreement with the result of Blake and Ruppersberg. E. H. B.

1215. *Damping of Hertz Oscillations.* **M. Levitsky.** (Phys. Zeitschr. 12. pp. 386–391, May 15, 1911.)—A straight Hertz oscillator excites oscillations in a rod resonator which is provided with a thermo-couple at its centre. The resonance curve is obtained as the length of the oscillator is altered. In order that the damping of the resonator may be reduced to a minimum, the resonator is surrounded by a metal sphere which has a small opening, cut parallel to the resonator. Through this opening the incident radiation passes.

In front of the sphere is a large metal screen with an opening of the same size. The resonance curve is very much more pronounced when the resonator is inside the sphere than when it is not, and it is possible to use the curve for the determination of the damping of the oscillator. If the damping of the resonator when surrounded by the metal sphere is assumed to be negligible, the damping of the oscillator comes out very nearly that calculated by means of Abraham's formula. T. P. B.

1216. *Demonstration of Resonance Curves.* **F. Kock.** (Phys. Zeitschr. 12. pp. 879–886, May 15, 1911.)—A piece of apparatus is described by means of which resonance curves may be directly recorded by photography or demonstrated to an audience. The secondary of two coupled circuits includes a variable self-induction consisting of two coils of which one rotates inside the other. The secondary circuit is thus brought into resonance with the primary once during each half revolution of this coil. On the axis of rotation is mounted a wooden disc to which is fixed a Gehrcke oscillograph tube [Abstract No. 2100 (1905)]. The tube is either connected directly across the capacity or excited inductively. The length of the glow in the tube thus rises to a maximum, and then falls off again in each half revolution, and, therefore, if the oscillations are excited continuously, an illuminated surface is obtained of which the boundary is the resonance curve. If the oscillations are excited by the spark method, only one ordinate of the resonance curve is seen at each spark. For photographic or demonstration purposes, the spark must take place for a short time always at the same point of rotation. This is arranged by means of a suitable break mounted on the axis of rotation. By altering the position of this break a series of ordinates of the resonance curve is obtained. If the curves are to be used for measurements of damping, the glow tube is calibrated by means of a thermo-element; the damping due to the glow-tube is determined by experiment and eliminated, and the fact that the illuminated surface is curved is taken into consideration. With these corrections the results show that damping determinations may be made with some accuracy. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1217. *Duration of Electrical Contact between Impacting Spheres.* **A. E. Kennelly and E. F. Northrup.** (Frank. Inst., Journ. 172. pp. 28–38, July, 1911. Electrician, 67. p. 901, Sept. 15, 1911. Abstract.)—Within the limits of range and accuracy covered by the experiments the authors conclude as follows: (1) If a metallic sphere impinges upon another like metallic sphere, the duration is proportional to the diam. of the sphere. Hence the *specific duration* (or duration per cm. of diam.) depends only on the nature of the surfaces and the velocity of impact. (2) The harder the metals the shorter the specific duration. (3) The specific duration varies inversely as the tenth root of the height h of vertical drop, or equals $a/h^{1/10}$ in microseconds per cm. (4) For a steel ball on a steel ball $a = 85$ nearly. E. H. B.

1218. *Best Dimensions of Induction Coils.* **M. La Rosa and G. Pasta.** (N. Cimento, 1. Ser. 6. pp. 81–114, Feb., 1911.)—Modern practice makes the secondary of an induction coil a little longer than the spark required; to the core a much greater length is given (as much as double), and a diam. from 0·1 to 0·06 of its length; and to the primary coil a length of 0·8 to 0·9 that of the core. The practical problem is to link the largest flux with a given length of wire. The author investigates theoretically and experimentally the best dimensions, and concludes that by making the external radius of the secondary twice the internal radius, and the length of the secondary 0·8 of the length of the primary, an efficiency can be obtained which exceeds that of the usual patterns by 50 or 60 per cent. E. E. F.

1219. *Comparison of Two Self-inductions.* **A. Anderson.** (Phil. Mag. 21. pp. 608–610, May, 1911.)—If we have 2 coils with self-inductances which are not equal, they may be made equal by shunting one of them with a non-inductive resistance. Let it be desired to compare the self-inductions L and N of 2 coils whose resistances are R and S. Place the coils in the adjacent arms of a bridge so that when balance is obtained the same current passes through each. In the other arms of the bridge place 2 non-inductive resistances, equal respectively to R and S. There is thus a balance for steady currents. Let the 2 coils of resistance R be shunted by equal but variable non-inductive shunts Q, and let the shunts be varied until there is no transient current. Then $N = LQS/R(R + Q)$. Clearly N must not be greater than LS/R. Otherwise the shunts must be applied to the other two arms.

F. E. S.

1220. *The Resistance of Pure Mercury at Helium Temperatures. Further Experiments with Liquid Helium.* IV. **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 1274–1276, May 26, 1911. Communication No. 120*b* from the Phys. Lab., Leiden. Electrician, 67. pp. 657–658, Aug. 4, 1911. Abstract.)—The author previously [Abstract, No. 772 (1911)] deduced a formula for the resistance of solid mercury, based on the idea of resistance vibrators. From this it was concluded (1) that the resistance of pure mercury would be found to be much smaller at the boiling-point of helium than at hydrogen temperatures, although its accurate quantitative determination would still be obtainable by experiment; (2) that the resistance at that stage would not yet be independent of the temperature; and (3) that at very low temperatures such as could be obtained by helium evaporating under reduced pressure the resistance would, within the limits of experimental accuracy, become zero. Experiment has confirmed the forecast. While the resistance at 13·9° K. (Krypton thermometer) is still 0·034 times the resistance of solid mercury extrapolated to 0° C., at 4·3° K. it is only 0·0013; and at 3° K. it falls to less than 0·0001. With regard to the value of the frequency of the resistance vibrators assumed before, it is worth noting that the wave-length *in vacuo*, which corresponds with the period of the mercury resistance vibrators, is about 0·5 mm., while Rubens has found that a mercury lamp emits vibrations of very long wave-length of about 0·3 mm. In this way a connection is revealed between the change with temperature of the electrical resistance of metals and their long-wave emission. Errata to a previous paper [Abstract No. 772 (1911)] are given. A. F.

1221. *Measurement of Specific Inductive Capacity.* **C. Niven.** (Roy. Soc., Proc. Ser. A. 85. pp. 139–145, April 11, 1911.)—The discrepancy between Maxwell's theory of refraction and the values of the dielectric coefficients of some of the common liquids is well known. The idea which naturally suggests itself is that since the first values deduced for these coefficients were obtained by slowly alternating electric forces, it is possible that the results of experiments with rapidly alternating electric forces would give results in better agreement with Maxwell's theory. A modification of Thwing's resonance method is employed. Fleming's cymometer was used as an adjustable resonator. The frequency used was of the order of a million, but the cymometer was only used to give comparative readings, the capacity of a liquid condenser being compared with that of another with air between the plates. The theory of the oscillations of a liquid condenser, which are complicated by the conduction which takes place through the liquid, is given in full, and the condition for resonance is in practical agreement with that found by Thwing. The following values for the dielectric coefficient, λ, of water were found by this method:—

Temperature, Centigrade.	0°	7°	33°	59·5°	83°
Dielectric coefficient ...	90·36	80·06	69·31	58·82	87·97
Temperature coefficient...	—	—	− 0·64	− 0·54	− 0·63

Similar observations were made with alcohol as a dielectric. The values of the dielectric coefficient were found to be 24·5 and 16 at 12° C. and 64·2° C. respectively, giving a variation between 12° C. and 64° C. of − 0·16 per deg. C. A. R.

1222. *Peltier-effect.* **F. W. Jordan.** (Phil. Mag. 21. pp. 454–464, April, 1911.)—The paper describes a form of apparatus for the direct measurement of the Peltier coefficient between copper and a short specimen of crystallised Bi in the limited space between the poles of an electromagnet. The method is somewhat similar to one suggested by Pellat, in which the Peltier absorption of heat is compensated by the heat evolved by a current through a fine insulated wire embedded in the metal close to the junction. The Peltier-effect will produce in each bar a temperature gradient towards the junction, and therefore to compensate this the current through the fine wire is adjusted so that the temperature gradient, as indicated by insulated thermo-junctions, vanishes in each bar. Jordan's apparatus is equivalent to a duplication of Pellat's arrangement, which gives many subsequent advantages. If a current be sent round a circuit of two metals, then the temperature-difference between the junctions arising from the Peltier-effects can be made to vanish by a continuous supply of heat to the cooler junction. In the ideal case when the junctions are equal in all respects, the rate at which heat must be supplied to the cooler junction is equal to twice that at which it is evolved at the warmer junction. The thermal conductivity of Cu is much greater than that of Bi, and therefore it is preferable to supply the heat by the passage of a current through an insulated fine wire embedded in the Cu close to each junction. The presence of the heating coil at each junction renders it possible to eliminate from the final result the electrical resistances and the different thermal emissivities of the junctions. The apparatus is so dimensioned that at each junction the Joule heat for the average current of 1 amp. is only about one-tenth of the Peltier heat. Full details are given of the apparatus, of the method of preparing the Cu and Bi rods, and of the manner of calculating the Peltier coefficient. A. D. R.

1223. *Thomson- and Peltier-effects.* **F. W. Jordan.** (Nature, 86 p. 380, May 18, 1911.)—The paper describes a simple form of apparatus for demonstrating the existence of the Thomson-effect in copper and the Peltier-effect at the junction of two dissimilar metals. The apparatus consists of a longitudinally-partitioned glass tube with a suspended mica vane at the top of the partition, constituting a Joule radiometer. A thin copper wire attached to thick copper leads runs diametrically at the bottom of the tube, and the mica vane is deflected owing to the Thomson-effects, and the inequality of the Joule-effects in the two halves of the wire. The Peltier-effect is shown by using an iron wire soldered to another pair of copper leads. The deflections of the vane are recorded by a lamp, mirror, and scale arrangement. A. D. R.

1224. *Radium Apparatus for Continuous Motion.* **H. Greinacher.** (Deutsch. Phys. Gesell., Verh. 13. 10. pp. 398–404, May 30, 1911.)—The paper deals with a modification of Strutt's "radium clock." [Abstract No. 171 (1904)]. A piece of brass placed in a block of paraffin absorbs β-rays from an external source of radium, and communicates its negative charge to a needle which charges up and discharges itself continuously. No vacuum is necessary, as the needle is arranged to be 1 m. from the Ra and the connecting wire is embedded in paraffin. The apparatus is useful for demonstration purposes. E. M.

1225. *Ionisation Vessel for the Determination of Radio-active Radiations.* **H. Greinacher.** (Phys. Zeitschr. 12. pp. 209–214, March 15, 1911.)—The apparatus described consists of a hemispherical cavity in wood coated on the inside with Al and having an Al base. The radius is 9 cm., so that the longest-range α-particle, *i.e.*, those from thorium C, can be measured in it. The measurements are made with an electrometer, and either a ring or rod electrode is used, particulars being given of the efficiency for α- and β-radiation with various sizes of electrodes. E. M.

ALTERNATING CURRENTS AND MAGNETISM.

1226. *Effect of Deformation upon Magnetic Properties of Nickel.* **G. Ercolini.** (N. Cimento, 1. Ser. 6. pp. 237–268, April, 1911.)—Following a similar set of experiments upon iron [see Abstract No. 674 (1911)] the author subjects nickel wires, both crude and annealed, to continuous and alternating magnetic fields and to cycles of tension and torsion. The conclusions arrived at are numerous and complicated, but broadly, the magnetic properties depend greatly upon the elastic condition of the specimen. When the field is sufficient to reduce the magnetic hysteresis the mechanical action is negligible. The elimination of hysteresis by the alternating field and by longitudinal vibrations produced in the nickel by magnetostriction, leads to very simple results. S. G. S.

1227. *Magnetisation of Iron in Two Fields at Right Angles.* **G. Ercolini.** (N. Cimento, 1. Ser. 6. pp. 375–398, May, 1911.)—The two magnetic fields are produced, one by placing the iron wire inside a solenoid and the other by passing a current through the wire itself. The results are complicated, and the author draws from them the following conclusions: (1) That just as in the case of torsion [see Abstract No. 674 (1911)], the secondary field tends to reduce the hysteresis phenomenon due to the primary field; (2) that the effect depends not only upon the order of application of the othogonal fields and the region of susceptibility in which they are applied, but upon the method by which they are maintained; (3) that when the values are not great the effects may be predicted from a consideration of the reversible magnetic curves. S. G. S.

1228. *Absolute Measurement of Magnetic Fields.* **P. Sève.** (Comptes Rendus, 152. pp. 1478–1480, May 29, 1911.)—The field to be measured (H) by the ballistic method, contains a coil of area *s* in circuit with another coil of area S placed in a known field *h*, due to the passage of a known current through a solenoid. When the quantity of electricity induced by withdrawing the first coil is equal to that resulting from the reversal of the current in the solenoid, $Hs = 2hS$. The equality of these two fluxes was determined by means of a fluxmeter, and the ratio of the two areas by an alternate-current method which requires that the reactances of the circuits are small in comparison with their ohmic resistances. [See also Abstract No. 997 (1910).]

G. E. A.

1229. *Previous Magnetic History as affected by Temperature.* **E. Wilson and L. C. Budd.** (Phys. Soc., Proc. 23. pp. 253–256, June 15, 1911.)—The effect of variation of temperature upon the influence of previous magnetic history on permeability is examined in ring specimens built up from stampings of stalloy, an iron alloy containing about 3 per cent. of Si. A set of B-H curves is given for various temperatures with and without previous history. In every case the previous force was about 20 c.g.s., and in every case the curve given by the demagnetised material lay above that for which there was previous history. The effect is most marked for liquid-air temperature, and it diminishes with rise of temperature; it probably vanishes at the temperature at which the material becomes non-magnetic. G. E. A.

1230. *Magnetisation Curves of Iron by the Method of Constant Rate of Change of Flux.* **J. T. Morris and T. H. Langford.** (Phys. Soc., Proc. 23. pp. 277–300; Discussion, p. 300, June, 1911. Electrician, 67. pp. 776–779, Aug. 25, 1911. Abstract.)—In this ring method, the magnetising current in the primary is continuously increased, by means of a specially designed rheostat, at such a rate as to induce a constant voltage in the secondary. A certain amount of skill is required in operating the resistance, and the complete change of current can be made in from one up to five minutes. In a comparison of this method with five others, in which the field was varied from 0·8 up to 70 c.g.s., the above method gave, for low values of the magnetising force, results of some 200 lines per sq. cm. in excess of the older methods. Besides rapidity of experiment, the method of uniformly varying flux has the advantage of accuracy of repetition under given conditions of magnetic change. In the *discussion* it was pointed out that the method could be used for the determination of the ohm by substituting a known mutual induction for the iron under test. G. E. A.

1231. *Magnetic Properties of Electrolytic Iron.* **W. Kaufmann and W. Meier.** (Phys. Zeitschr. 12. pp. 518–522, July 1, 1911.)—The authors have tested the accuracy of Maurain's statements [see Abstracts Nos. 2285 (1900) and 892 (1901)] that a field of 10 to 15 gauss was sufficient to saturate electrolytic iron if applied during its deposition, and that the substance gives a hysteresis loop of almost rectangular parallelogram shape. The chief results obtained are: (1) A hysteresis loop of the form given by Maurain is obtained whether the iron is magnetised during or after deposition. (2) Maurain's loop is obtained only if the composition of the electrolytic solution is within certain limits. (3) The shape of the loop approximates fairly closely to one of R. Gans's theoretical curves. (4) Iron deposited in a magnetic field is more easily saturated. A feeble constant field also acts on this iron as on ordinary iron subjected to mechanical vibration. (5) The electrolytic iron changes its magnetic properties very quickly, probably through giving up hydrogen. The initial properties can be restored by kathodic polarisation of the metal. The paper gives details of the method of preparing the electrolytic iron and of carrying out the magnetic tests. It concludes with a comparison of the results with the theory of Gans, which makes it seem probable that we are here concerned with a condition of iron which at least comes very near to that of Gans's elementary substance—a condition with absolutely no molecular grouping. A. D. R.

1232. *Curie's Law at Low Temperatures.* **H. Kamerlingh Onnes** and **A. Perrier.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 115–122, June 28, 1911. Communication No. 122a from the Phys. Lab., Leiden.)—The paper gives results of preliminary experiments on the specific susceptibility, χ, of certain para- and dia-magnetic substances at very low temperatures. Details of apparatus and methods are reserved for a further communication. Gadolinium sulphate agrees perfectly with Curie's law down to about 15° abs.; thereafter it shows too small a susceptibility—a departure from the law which appears in iron and other paramagnetic salts at a much higher temperature. Some substances at temperatures beneath those at which Curie's c/T law is obeyed follow more nearly a $c/\sqrt{T}$ law. None of the salts investigated showed signs of a saturation phenomenon. As liquid hydrogen was used in the tests a determination was made of its susceptibility. A volume susceptibility $K = -0{\cdot}186 \times 10^{-6}$ was obtained (with a probable error of less than 10 per cent.), which, assuming Dewar's value 0·07 for the density of liquid hydrogen, gives $\chi = -2{\cdot}7 \times 10^{-6}$, a result in good agreement with that deduced by Pascal from organic compounds. A. D. R.

1233. *Interpolation of Magnetisation Curves.* **M. La Rosa.** (N. Cimento, 1. Ser. 6. pp. 115–119, Feb., 1911.)—Gives the following rule, based upon Rayleigh's reduction rule: Given two magnetisation curves, corresponding to the values N_1 and N_2 of the demagnetisation factor, to find the value of the field to be employed to make a magnetic circuit of any demagnetisation factor N_c (between N_1 and N_2) acquire a given intensity of magnetisation; mark on each of the curves the point having as ordinate the magnetisation required, and divide the distance between the two points in the ratio $(N_1 - N_c)/(N_1 - N_2)$. The dividing point indicates the field required. E. E. F.

1234. *Hall-effect in Graphite.* **E. van Aubel.** (Comptes Rendus, 153. pp. 331–333, July 31, 1911.)—Specimens of homogeneous and laminated Siberian graphite have been tested for the Hall-effect and compared with specimens of pure Kahlbaum antimony and bismuth. The effect in graphite is in the opposite sense to that in Sb and in the same sense as that in Bi, just as has been found for other varieties of carbon; it is, however, for homogeneous graphite more than five times greater, and for the laminated graphite about twice as great as the effect in Sb. The intensity is therefore not much less than that in Bi. A. D. R.

1235. *Effect of Speed on the Compass.* **G. Gaillard.** (Comptes Rendus, 152. pp. 809–810, Feb. 6, 1911.)—It is well known that a long-continued east to west course develops opposite magnetic polarity in the starboard and port sides of a ship. The speed of some British destroyers is so great that it seemed possible this might give rise to an effect on the compass varying with the speed. Preliminary experiments on a railway carriage travelling at speeds of 80 to 120 km. have given definite evidence of such an effect, in spite of the effects being largely masked by secondary effects. G. W. DE T.

1236. *Terrestrial Magnetism.* **C. della Salda.** (Elettricista, Rome, 10. pp. 177–180, June 15, 1911.)—On the analogy of the inverse square law, the author calculates the magnetic field due to a rotating sphere such as the earth, and finds it of the form similar to the actual terrestrial magnetic field. Thus if a moving mass has a magnetic field similar to that due to a moving charge, the electrical equivalent of 1 gm. of matter for the production of the earth's actual magnetic field is $0{\cdot}26 \times 10^{-14}$ c.g.s. electromagnetic units. The value calculated from the variations caused by the moon gives, on the same assumption, a constant of the same magnitude. S. G. S.

1237. *Magnetogram Time Scales.* **R. L. Faris.** (Terrestrial Magnetism, 16. pp. 109–112, June, 1911.)—The five magnetic observatories of the Coast and Geodetic Survey of the United States are all equipped with a complete set of Eschenhagen type variometers, the photographic recording apparatus being so arranged that a time interval of 1 hour on the magnetogram is about 20 mm. in length. The beginning of each hour is indicated by the interruption of the trace automatically, and in addition, a special interruption is made by the observer every day, generally about 8 a.m., the exact time being recorded. Details are given of the procedure of measurement of the magnetograms, and an illustration of the accuracy attainable is given for the disturbance produced by a lightning storm on July 12, 1910. C. P. B.

1238. *Theory of the Secular Variation of the Earth's Magnetism.* **L. A. Bauer.** (Phys. Zeitschr. 12. pp. 445–448, June 1, 1911.)—The author criticises the data used by Bidlingmaier in drawing his conclusions [see Abstract No. 391 (1911)] as to the secular variation being due to the increase and diminution of magnetic material in the earth's interior at a depth of about 25 km. where the temperature is about 750° C.—the critical temperature of iron. He argues that the observations do not bear out the conclusions that have been drawn, and he offers as an alternative the theory that the secular variation is due to alteration in the strength of electric currents outside the earth, these currents, in the main, producing the phenomenon of terrestrial magnetism. [See Abstracts Nos. 998, 999, and 1339 (1910)]. A. D. R.

1239. *Secular Variation of the Earth's Magnetism.* **F. Bidlingmaier.** (Phys. Zeitschr. 12. pp. 449–459, June 1, 1911.)—The author points out an error in the mathematical discussion in his previous paper [see Abstract No. 391 (1911)] which has had a serious effect on the conclusions reached. In this paper he discusses anew the hypothesis that the secular variation is caused by a stratum of the earth's crust at a depth of less than 30 km., which is sometimes above and sometimes below the critical temperature and which is subjected to the magnetising field of the earth. He finds that the hypothesis is untenable, for to account for the amount of secular variation in a year he would require a thickness of from 200 to 800 km. for the layer affected, if formed of the highly magnetic rock basalt. In the second part of the paper he gives in tabular form and on charts of the world, the yearly rate of change in the earth's magnetic field for various epochs from 1650 to the present time. In conclusion, he states that it is probable that the cause of secular variation lies in electric currents in the neighbourhood of the earth, but whether these are external or internal currents is at present not known.

A. D. R.

1240. *Origin of the Earth's Magnetism.* **L. A. Bauer.** (Terrestrial Magnetism, 16. pp. 118–122, June, 1911.)—The author discusses further his theory that the earth is chiefly an electromagnet, the magnetising currents being outside and consisting of negative electric currents circulating overhead from west to east [see Abstracts Nos. 998, 999, and 1839 (1910)]. The external currents are revealed by the harmonic analysis of the magnetic elements observed on the earth's surface, and the earth's magnetism can be explained if the earth be paramagnetic with an average permeability of the order of 185 for $H = 0{\cdot}0024$ c.g.s. unit. The author points out that while Gauss taught that the observed magnetic forces can be almost wholly referred to a potential and showed how to separate effects due to internal magnetic or electric systems from those due to outside ones, he made no attempt to interpret physically any of the terms of his total potential. The hypothesis advanced by A. Schmidt to account for terrestrial magnetism is reviewed and the author shows that the general view adopted therein is in harmony with his own theory. A. D. R.

1241. *A Null Method for Measuring Relative Intensities of Röntgen Rays.* **W. R. Ham, L. J. Lassalle, and O. F. Smith.** (Frank. Inst., Journ. 172. pp. 78–91, July, 1911.)—The work described in this paper investigates the two following hypotheses: (1) The amount of ionisation caused in an ionisation chamber by rays emanating from the target of a Röntgen-ray tube, varies inversely as the square of the distance of the chamber from the target. neglecting absorption—provided the rays are travelling through a medium which exerts no appreciable absorption upon them. (2) The amount of ionisation caused in an ionisation chamber by Röntgen or other rays having ionising power, varies directly as the area of the opening allowing the rays to enter the chamber. The experimental details are given and the results shown both in tabular and graphical form. A. E. G.

REFERENCES.

1242. *Quarternions applied to Electrical Theory.* **A. W. Conway.** (Roy. Irish Acad., Proc. 29. pp. 1–9, March, 1911.)—A highly mathematical discussion of fundamental formulæ, the Fredholm solutions, and the relativity principle by quarternions instead of by vector methods without the use of quarternions. [See Abstract No. 1312 (1909).] E. H. B.

1243. *Electric Theory.* **F. Sanford.** (Leland Stanford Univ. Publications, No. 6. pp. 5–69, May 15, 1911.)—A non-mathematical account of electric phenomena in which the endeavour is made to provide a theory on the basis of electrons and the positively charged or material part of the atom, repulsion being regarded as more fundamental than attraction. E. H. B.

1244. *Sizes and Charges of Molecules.* **J. Perrin.** (Comptes Rendus, 152. pp. 1380–1382, May 22, 1911.)—By determinations of N from Brownian movements the author finds for the electron the value $4{\cdot}2 \times 10^{-10}$ with a probable error of less than 2 per cent. [See Abstracts Nos. 1816 (1908); 2130 and 2131 (1909).] E. H. B.

1245. *Electromagnetic Phenomena in Moving Bodies.* **J. Ishiwara.** (Mathematico-Physical Soc., Tôkyô, Proc. 6. 5. pp. 72–81, May, 1911.)—Highly analytical discussion on the relativity principle. [See Abstracts Nos. 2123 (1909) and 149 (1911).] E. H. B.

1246. *The Faraday-Maxwell Law of Electromagnetic Induction.* **L. de la Rive.** (Archives des Sciences, 31. pp. 118–123, Feb., and pp. 209–210, March, 1911.)—A simple direct mathematical proof is given, by the aid of Stokes' theorem, that the law holds good in the case of an element of a convection current, such as an electron. G. W. DE T.

1247. *Initial Accelerated Motion of a perfectly conducting Electrified Sphere.* **G. H. Livens.** (Phil. Mag. 21. pp. 640–648, May, 1911.)

1248. *Atmospheric Electricity.* **M. Behacker.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 675–684, May, 1910.)—A mathematical paper dealing with the calculation of the field intensity in the atmosphere on the supposition of a homogeneous ionisation. Tables are finally deduced showing the field intensity at each 100 cm. distance from the earth's surface in terms of the field at the surface, the tables extending to 800 cm. These are compared with the table given by v. Schweidler in his paper on the ionisation in the lower layers of the atmosphere [Abstract No. 113 (1909)], and are seen to be in fair agreement. A. W.

1249. *Ionisation of Salt Vapours.* **G. Moreau.** (Comptes Rendus, 152. pp. 1664–1666, June 12, 1911.)—Deals with (1) the conductivity in flames owing to the ionisation of saline vapours, and (2) the recombination of the ions in a flame. E. H. B.

1250. *Interkathodic Action in a Uniform Magnetic Field.* **Gouy.** (Comptes Rendus, 152. pp. 989–992, April 10, 1911.)—This paper is almost entirely of a theoretical nature. The explanation of the phenomena previously given [see Abstract No. 265 (1911)] is further developed in respect to the connection between the effects observed and current ideas as to discharges in rarefied gas. A series of experiments which support the views put forward are briefly described at the end of the paper. A. E. G.

1251. *Study of the Nature of the Electric Spark.* **E. Caudrelier.** (Comptes Rendus, 152. pp. 762–763, March 20, 1911.)—In preceding papers [see Abstracts Nos. 1284 (1909) and 717 (1910)] experiments are described to illustrate the nature of the electric arc. In this paper the effect of the initial ionisation of the air is considered. A. R.

1252. *Effect of a Lightning-flash on an Antenna.* **A. Turpain.** (Journ. de Physique, 1. Ser. 5. pp. 372–381, May, 1911. Paper read before the Soc. franç. de Physique, Jan. 20, 1911.)—A detailed account of the effect of a flash of lightning on an antenna and recording apparatus used for the registering of atmospheric discharges. The paper cannot be abstracted. T. P. B.

1253. *Electron Theory of Thermo-electricity.* **K. Baedeker.** (Ann. d. Physik, 35. 1. pp. 75–89, June 2, 1911.)—[See Abstract No. 1639 (1910).]

1254. *Magnetic Induction in an Ellipsoid having three Axes.* **E. Daniele.** (N. Cimento, 1. Ser. 6. pp. 421–430, June, 1911.)—Mathematical.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1255. *Atomic Heats of the Elements.* **J. Koenigsberger.** (Zeitschr. Elektrochem. 17. pp. 289–298, April 15, 1911.)—The experimental work of Nernst, Korff, Magnus, and Lindemann [Abstracts Nos. 821 and 942 (1910)] in connection with the theories of Richarz, Einstein, and Reinganum [Abstracts Nos. 489 (1907), and 1258 (1909)], enables us to arrive at some conclusion with regard to the part played by electrons in the atomic heat of the elements. The author shows qualitatively that that part is a considerable one. Quantitative evidence must wait for a more thorough working-out of the electron theory of galvanic and thermoelectric phenomena. The influence of the metallic state is brought out clearly by comparing substances of simple crystalline structure (and therefore, probably, atomic constitution) which have similar atomic weights. Such are lithium, graphite, and diamond, whose atomic heats are 4·5, 1·8, and 0·72 respectively. Most metals have monatomic vapours and crystallise in the regular system. Their atomic heats consist of two portions between −150° and +1500°, one of these being that due to the kinetic energy of electrons, the other due to the energy of the atoms. At −150° the former is negligible, and the atomic heat should be 8. When, at higher temperatures, the degrees of freedom of two electrons per atom come into play, it should rise to 9. This is approximately verified.
E. E. F.

1256. *Action of Ultra-violet Rays on Air.* **W. Chlopin.** (Zeitschr. Anorg. Chem. 71. 2. pp. 198–205, June 8, 1911.)—Ordinary air, not deprived of its moisture, is directly exposed to the radiations from the mercury arc (quartz tube) of a Westinghouse steriliser, and the gases are analysed with the aid of 8 reagents, comprising titanium sulphate, metallic silver (etched with nitric acid), Griess' reagent, and the "ursol" paper of G. W. Chlopin, in whose hygienic institute in St. Petersburg the author is working. The formation of H_2O_2, ozone, and of traces of nitrous acid anhydride can be proved after a few minutes. Quantitative determinations are being made.
H. B.

1257. *New Resistance Furnace.* **F. A. J. FitzGerald.** (Amer. Electrochem. Soc., Trans. 19. pp. 273–284; Discussion, p. 284, 1911. Metallurgical and Chem. Engin. 9. pp. 259–262, May, 1911.)—Experiments with the furnace described in Abstract No. 1149 (1910) were made by the author, partly in conjunction with Imbert at the Hohenlohehütte in Upper Silesia, and partly at Niagara Falls. Imbert reduces zinc by iron from its sulphide, and dissolves the charge in a fused mixture of one part of iron oxide and three of iron sulphide. By charging the furnace with fused metal and keeping the temperature constant with the aid of the current, the heat losses in the furnaces have been determined. The furnace is box-shaped; the resistance forms two parallel flat arches extending from the one electrode of a pair to the other; the resistance consists of corrugated carbon or carborundum plates, set up like bricks fitting into one another to form an arch. The arches are supported by magnetite bricks which suffer from the high temperature (up to 1900° C.). The furnaces are recommended for metallurgical operations and glass-melting; the electrodes do not require regulation. H. B.

1258. *Formation of Metallic Solid Solutions by Diffusion in the Solid State.* **G. Bruni and D. Meneghini.** (Accad. Lincei, Atti, 20. pp. 927–931, June 18, 1911.)—Employing the method already used for a Cu-Ni alloy [Abstract No. 1058 (1911)] the authors have proved the formation of solid solutions by diffusion into one another of Cu and Au, and of Au and Ag, the resulting alloys containing 52·5 per cent. Au, and 62·8 per cent. Ag respectively. Gold wire of about 0.5 mm. diam. was coated electrolytically with the Cu or Ag, the electric resistance of the Au-Cu alloy, maintained at 800° C., becoming constant after 98 hours, and that of the Ag-Au alloy, at 900° C. after 110 hours. Experiments with cylinders consisting of alternate thin layers of the metals, show that diffusion is completed much more rapidly with increased surface of contact, and microphotographs of sections of these, before and after diffusion has taken place, are reproduced. No pressure on the internal wire could occur in any of these experiments, since in each case the coefficient of expansion of the external metal has been greater than that of the core. W. H. Si.

1259. *Laboratory Production of Aluminium.* **H. K. Richardson.** (Amer. Electrochem. Soc., Trans. 19. pp. 159–166; Discussion, pp. 166–170, 1911.)—The author found cells of Winteler and the method of fusion of Neumann and Olsen better than the cell of Tucker, which gave poor yields. The best mixture is 85 per cent. of cryolite with 15 of alumina, and the current density 8 amps./cm.² of anode surface. The anode may become enveloped by gas; this may be cured more or less by tapping the anode, by interrupting the current, or by adding cryolite or alumina. The *discussion* by **J. W. Richards, A. H. Cowles, F. A. Lidbury,** and **S. A. Tucker** concerned chiefly the questionable solubility of metallic Al (as such) in the bath and its influence upon the yield. H. B.

1260. *Constitution of Troostite.* **A. McCance.** (Inst. Mech. Eng., Proc. 4. pp. 1661–1680; Discussion and Communications, pp. 1680–1698, Oct.–Dec., 1910. Engineering, 90. pp. 905–908, Dec. 30, 1910. Abstract.)—Describes experiments carried out with the object of finding one principle connecting many scattered observations on the nature and properties of troostite, especially in relation to the tempering of steel. The author concludes that troostite consists essentially of α iron which is in the amorphous condition, or which has not yet attained its crystalline state of ferrite, and which contains carbon in suspension and not in solution as carbide of iron. The exact position of troostite in the heat treatment of steel is shown in a diagram, using the contraction curve as a basis. This diagram shows the relation between troostite and the Ar_1, or Ar_{32}, change, during the cooling of steel. Of the other explanations which have been offered, Benedick's theory of a colloidal solution of carbon in β iron fails when it is shown that a growth of troostite corresponds with an increase in permeability, for β iron is known to be non-magnetic; but there are undoubted analogies between troostite and colloids. The hypothesis outlined by the author embraces both le Chatelier's views and the ideas of Benedicks (with reservations). The discussion and communications are controversial and unsuitable for brief abstracting.

C. O. B.

1261. *Influence of Nature of Surface on the Rusting of Iron.* **K. Arndt.** (Metallurgie, 8. pp. 853–858, June 22, 1911.)—The anomalous behaviour of some kinds of iron is discussed in the light of the electrolytic theory of corrosion.

Variations in the nature of the surface, whether as a result of different chemical, physical, or mechanical condition, will give rise to different behaviour during rusting. It is characteristic of cast iron to rust uniformly, while steel and wrought iron rust in patches. The skin of oxide has considerable influence on the tendency to rust. Tubes of wrought iron or steel with a good rolling skin resist rusting, while tubes with a poor or damaged skin rapidly corrode. Local damage often results in the tube being pierced. Cast-iron tubes have the most tenacious skin, but appear to rust rapidly at the commencement, afterwards rusting more slowly. F. C. A. H. L.

1262. *Annealing Temperatures for Malleable Castings.* **W. P. Putnam.** (Mech. Eng. 28. pp. 33-35, July 14, 1911. Paper read at Pittsburg Convention of the American Foundrymen's Assoc.)—The correct annealing temperature to be used in the annealing process for the manufacture of malleable iron castings is given for castings containing varying percentages of carbon. This temperature varies from 1540° F. for castings containing 2·4 per cent. carbon to 1640° F. for castings containing 3·0 per cent. carbon. Diagrams are given showing variations in temperature in the furnace and also inside the pots during the annealing process, and analyses are given showing variations in composition due to annealing. C. O. B.

1263. *Transition Points of Copper-Aluminium Alloys..* **M. Barrée.** (Revue de Metallurgie, 7. pp. 16-33, 1910. Metallurgie, 8. pp. 377-378, June 22, 1910.)—The author has made experiments on the variation of electrical resistance with temperature in alloys containing 8-15·5 per cent. Al, with a view to determining the temperature at which transitions take place in the solid. The results show that a very decided change occurs at 500° C., and a lesser change at 750° C., thus confirming the results of Guillet. All the curves showed a discontinuity at 200° C. The changes are reversible, and occur at lower temperatures on cooling than on heating, but the results were largely influenced by the phenomena of segregation. While repeated heatings do not influence the temperatures, the transition-points become much more definite—a fact probably due to the alloys becoming more homogeneous. F. C. A. H. L.

1264. *New Critical Points in Copper-Zinc Alloys.* **H. C. H. Carpenter and C. A. Edwards.** (Inst. of Metals, Journ. 5. pp. 127-149; Appendix pp. 150-157; Discussion and Communications, pp. 158-198, 1911. Engineering, 91. pp. 200-204, Feb. 10, 1911.)—Attention is drawn to the evidence in favour of the existence of a thermal change at about 470° in certain Cu-Zn alloys. This change was recorded by Roberts-Austen in 1897, who wrongly supposed it to indicate the presence of a eutectic. Shepherd [Abstract No. 2774 (1904)], Tafel, and Bornemann failed to get evidence of this change, and considered Roberts-Austen's observations to be due to experimental defects of his apparatus. The present authors have detected the change pyrometrically, both on heating and cooling curves, in all alloys containing the β constituent as a separate structural entity, *i.e.*, those containing about 68 to 40 per cent. Cu. The interpretation of the change is that at 470°, on cooling, β splits up into an intimate mixture of $\alpha + \gamma$; on heating, the reverse change takes place. Thus above 470° the stable phase is β, below 470° it is $\alpha + \gamma$. The resolution of β into $\alpha + \gamma$ has been detected microscopically in alloys containing pure β just above 470°. The practical consequence of the critical change is the embrittling of the alloy, owing to the brittle qualities of γ. On the assumption that alloys containing only the α constituent are really homogeneous mixtures of very minute crystals of copper + β, a possible explanation is obtained of the brittleness of α alloys that appears with lapse of time at ordinary temperatures and much more rapidly between 300 and 400°. This brittleness can be entirely removed by heating for a short time above 500° and cooling at ordinary rates. The confirmation of the existence of this critical change involves an alteration of the generally accepted equilibrium diagram of the Cu-Zn series. The critical change throws considerable light on the cause of the various types of corrosion and decay of brasses. The appendix by C. A. Edwards deals with the nature of solid solutions. It is suggested that a metallic crystalline mass, often described as a solid solution, is an intimate crystalline mixture, and whilst the primary crystals are so small that the mass appears quite homogeneous when viewed under the microscope, they are sufficiently large to retain their identity. The term, "solid solution," is considered not to be applicable, strictly speaking, to crystalline bodies such as metallic alloys, and should be restricted to supercooled liquids such as glass. With the exception of the two series of mixed crystals that may be formed at each end of a series, mixed crystals have a compound for their formation. C. O. B.

1265. *Physico-metallurgical Study of Aluminium Alloys containing Magnesium.* **A. Wilm.** (Metallurgie, 8. pp. 225–227, April 22, 1911.)—Just as carbon can confer the property of hardening on iron, Mg can cause Al to harden under a process of heat treatment; but since there are no appreciable volume or structural changes it is not possible to explain the mechanism of the transformation. The best temperature for quenching appears to be about 500° C., but whereas steel becomes hard immediately after quenching, the Al-Mg alloys are unchanged on quenching, but gradually increase in hardness on standing. One-half per cent. Mg is sufficient to cause hardening of pure Al, the phenomenon being assisted by the presence of other elements, such as Cu, Mn, Ni, &c., but these additions are liable to produce alloys which are not uniform because of segregation. Manganese protects Al against the action of mercury. Quenching not only increases the strength of these alloys but increases the ductility at the same time. Consequently the properties of cold-worked material can be considerably improved by heating to 500° C., quenching, and then subjecting to further work after standing about four days. The ductility of cold-worked material can be considerably improved without affecting the hardness and strength, by boiling in water, and for special purposes it can be annealed in an oil bath at 200° C. F. C. A. H. L.

1266. *Vanadium Alloys.* **G. L. Norris.** (Frank. Inst., Journ. 171. pp. 561–584, June, 1911. Mech. Eng. 27. pp. 811–814, June 30, 1911. Abstract.)—Gives an historical account of the element vanadium and also describes its chief applications in metallurgical industries. The metal is extracted from its ores by chemical means and converted into oxide for reduction. This oxide is mixed with iron oxide and powdered Al and reduced in magnesite-lined crucibles; the whole mixture is not fired at once as in the Thermit process, but is gradually fed into the crucible in small amounts, the action thus being less violent and under better control. Tests show that vanadium steels retain a much larger proportion of their hardness and strength at elevated temperatures than other steels. The value of chrome-vanadium steel for high-pressure cylinders is shown. Of the non-ferrous vanadium alloys, those with Cu and Al have industrial applications.

C. O. B.

1267. *Action of Concentrated Phosphoric Acid on Various Alloys.* **M. Wunder** and **B. Jeanneret.** (Comptes Rendus, 152. pp. 1770–1771, June 19, 1911.)—Phosphoric acid of sp. gr. 1·75, warmed to 230° C., is found to dissolve silicon, zirconium, and tungsten, ferro-silicon, ferro-titanium, ferro-vanadium, silico-manganese, titanium nitride, ferro-aluminium silicon, boro-nickel, and carborundum, giving syrupy solutions, and in some cases where Si is present, a white gelatinous deposit, insoluble in HCl. Addition of water causes no precipitation. Any carbon in the alloys remains undissolved.

W. H. Si.

1268. *The Marked Influence of Copper in Iron and Steel on the Acid Corrosion Test.* **W. H. Walker.** (Eng. News, 66. p. 156, Aug. 3, 1911. Paper read before the Amer. Soc. for Testing Materials.)—Four steels made in a basic open-hearth furnace were subjected to exactly the same mechanical and heat treatments except that small amounts of metallic copper were added to three of the steels during manufacture. The following results were obtained on testing for loss in a 20 per cent. solution of sulphuric acid :—

	A.	A_2.	B.	C.
Carbon, per cent.	0·08	0·08	0·10	0·09
Manganese, „	0·50	0·50	0·41	0·81
Phosphorus, „	0·017	0·017	0·026	0·068
Sulphur, „	0·018	0·018	0·027	0·081
Copper, „	—	0·21	0·19	0·19
Loss in 20 per cent. sulphuric acid in 8 hours, gm.	0·2235	0·0075	0·0082	0·0095

F. C. A. H. L.

1269. *Allotropic Varieties and Melting-point of Arsenic.* **P. Jolibois.** (Comptes Rendus, 152. pp. 1767–1769, June 19, 1911.)—Comparison of the behaviour, when heated, of arsenic chemically precipitated, and that deposited as a mirror shows that grey As is stable at all temperatures up to 850° C., while sublimed As is unstable at all temperatures, and undergoes irreversible transformation into grey As at about 280°. The melting-point of grey As is 850° ± 10° C.

W. H. Si.

1270. *Rate of Corrosion of Metals exposed in a Gaseous Atmosphere.* **A. W. Carpenter.** (Eng. News, 66. pp. 156–157, Aug. 3, 1911. Paper read before the Amer. Soc. for Testing Materials.)—Thin sheets of the metals to be tested were exposed in a railway tunnel and in the smoke jack of an engine-house. The conditions in the tunnel were less severe than those in the smoke jack, and the general results indicate that, of the ferrous metals, galvanised plates exhibit the greatest loss.

F. C. A. H. L.

1271. *Cementation of Nickel-steels.* **F. Giolitti** and **F. Carnevali.** (Accad. Sci. Torino, Atti, 46. 7. pp. 801–824, 1910–1911.)—An extension of the authors' investigations on the cementation process [see Abstracts Nos. 824 (1909), and 1546, 1547 (1910)] to nickel-steels, the course of the carburisation being studied for five steels containing 2, 3, 5, 25, and 30 per cent. Ni, about 0·1 per cent. C, 0·035–0·26 per cent. Si, 1·34–3·46 per cent. Mn, and no S or P, the carburising gas being either ethylene or CO. The max. content of carbon in the carburised zone diminishes with increase in the proportion of Ni, the decrease being specially marked when the Ni exceeds 5 per cent. The variation in concentration of carbon in successive strata is more uniform than in ordinary cementation-steel. Several photomicrographs are reproduced, one of which, of nickel-steel carburised with ethylene for 6 hours at 1050° C., shows a hypereutectic zone and a hypoeutectic zone, and proves that *qualitatively* the phenomenon is analogous to that occurring with ordinary steel, though *quantitatively* differing in (1) that the solution of the cementite is much less for nickel-steel, and (2) that the region of passage from hypereutectic to hypoeutectic zone corresponds to a carbon-content of 0·6–0·65 per cent. for nickel-steel, compared with 0·9 per cent. for ordinary steel. Planimetric observations made on several samples of nickel-steel containing known amounts of carbon confirm the concentration of carbon in the "pearlite" constituent as 0·6–0·65 per cent. W. H. Si.

1272. *Formation of Hydrogen Peroxide, Nitric Acid, and Ammonia by the Arc Discharge with One Water Electrode.* **A. Makowetzky.** (Zeitschr. Elektrochem. 17. pp. 217–235, March 15, 1911.)—Like Rasch [see Abstract No. 1968 (1907)] the author tries to use a water electrode. The discharge (a kind of brush arc of bluish colour, violet at its base on the water) is produced between water (diluted sulphuric acid) contained in a closed vessel of H-shape, and another electrode, either a water-cooled tube of Pt or a Nernst glower attached to a Pt-wire and cemented into a quartz tube with the aid of sealing-wax. The current is conveyed to the water through a sheet of Pt, immersed in the liquid in the lateral limb of the vessel. The water was positive against a hot kathode or negative against a hot anode; experiments with a cold anode above the water were not made, because a drop of water would condense on it, so that the anode was no longer surrounded by gas or vapour. The apparatus worked best with short arcs of 1 mm. length; the dynamo could supply 1 amp. at 6000 volts, but the arc p.d. did not exceed 1500 volts; the gas pressure was normal or below 760 mm. The discharge vessel was charged with nitrogen, or nitrogen was passed through it during the experiment. When the water is anode, the fall of kathode potential is small and only hydrogen and a little ammonia are formed. When the current is reversed, the kathode-fall becomes high, and the products are oxygen, hydrogen, ammonia, hydrogen peroxide, and nitric acid. Water-vapour seems to be decomposed at once into hydrogen and peroxide, near the water surface in the zone of the steep potential gradient; ammonia and nitric appear to be formed along the whole arc, especially when the current intensity is about 0·04 amp. In all cases it could quantitatively be demonstrated that the phenomena are the sum of electrolytic processes and of (non-polar) gas reactions: the white mists observed by Scheuer and ascribed by him to an unknown nitrogen oxide, were never seen, and the calculations would disprove their existence. Faraday's law, the author concludes, remains valid when one of the two electrodes is separated from the liquid by a layer of conducting gas. H. B.

1273. *Theory of Electrolytic Ions. IV. Diameter of Atoms and Ions.* **R. Lorenz.** (Zeitschr. Phys. Chem. 73. 2. pp. 252–255, 1910.)—The diams. of a number of univalent elementary ions have been calculated from the ionic mobilities by Einstein's formula, and the results compared with the diams. of the respective atoms, calculated by Reinganum's formula. The diam. of the ions found to be of the same order as that of the free atoms ($2·6 \times 10^{-8}$ cm.), except in the case of Li (ionic diam. double that of the atom). L. H. W.

1274. *Polymerised Water and Water of Crystallisation.* **A. Rosenstiehl.** (Journ. de Physique, 1. Ser. 5. pp. 288-294, April, 1911. Paper read before the Soc. franç. Physique, Feb. 17, 1911.)—A study of 177 hydrated salts has shown that 100 contain the complex $(H_2O)_3$, 52 the complex $(H_2O)_2$, and only 16 a single molecule of water. An alternative analysis shows the existence of every type of hydrate up to $(H_2O)_{12}$, but the only numbers appearing beyond this are 15, 18, and 24 (or 12 if the alums are written $Kal(SO_4)_2 . (2H_2O)$; the favoured numbers are 1, 2, 4, and 6 molecules. This is regarded as evidence in favour of trihydrol $(H_2O)_3$ as being the characteristic "ice-molecule" of Röntgen's theory. T. M. L.

1275. *Solubility of Water in Benzene, Petroleum, and Paraffin Oil.* **E. Groschuff.** (Zeitschr. Elektrochem. 17. pp. 348–354, May 1, 1911. From the Physikal.-Techn. Reichsanstalt.)—The materials had first to be deprived of their moisture. In the case of benzene this can be done with the aid of sodium, freshly fused, or of potassium-sodium; the benzene is kept over the metal and finally distilled. The oils, especially the transformer oils, are very difficult to dry; the main bulk of the water can be removed by heating the oil up to 120° C.; but the oil is partly decomposed then, and a discolouration is also observed when sodium or the K-Na alloy are used in the cold; a resinous substance is formed which renders the subsequent determination of the solubility difficult or impossible. This determination is made by the method of Alexejew (1886), improved by Rothmund (1898); weighed masses of the two liquids are mixed, and the temperature is observed at which stratification (or fogging) sets in or disappears. At 18° C. benzene absorbs 0·051, petroleum 0·005, paraffin 0·003 per cent. of water (by weight); the solubility increases with rising temperature. Thus petroleum and paraffin take up about as much moisture as the air, benzene takes up much more. The impurities of transformer oils may modify the solubility considerably, and conclusions cannot be drawn from the behaviour of the pure oils. H. B.

1276. *Relation of Osmotic Pressure to Temperature. V. The Measurements.* **H. N. Morse, W. W. Holland, E. G. Zies, C. N. Myers, W. M. Clark, and E. E. Gill.** (Amer. Chem. Journ. 45. pp. 554–608, June, 1911.)—The authors are now in a position to reject all measurements in which any trace of solution-leakage through the membrane could be detected, and all measurements in which changes of concentration occurred because the cell-contents were not at their proper temperature when the cell was closed. The remaining 147 series of measurements are summarised in three tables, of which the following is the most interesting:—

RATIO OF OSMOTIC TO GAS PRESSURE.

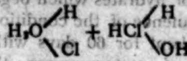
Weight-normal concentration	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
T=0°	1·106	1·061	1·061	1·060	1·0685	1·0765	1·083	1·098	1·104	1·115
5°	1·089	1·063	1·058	1·059	1·067	1·074	1·084	1·093	1·102	1·115
10°	1·082	1·060	1·059	1·060	1·066	1·073	1·083	1·092	1·103	1·113
15°	1·088	1·061	1·061	1·059	1·068	1·073	1·082	1·098	1·103	1·115
20°	1·084	1·062	1·060	1·060	1·067	1·073	1·084	1·093	1·103	1·115
25°	1·084	1·059	1·060	1·059	1·065	1·071	1·083	1·096	1·102	1·113
Mean	1·088	1·061	1·060	1·060	1·067	1·071	1·083	1·098	1·103	1·114

With the exception of the 0·1-N solution at 0°, which was within 0·2° of its freezing-points, the values are steady throughout the range from 0° to 25°, showing that Gay Lussac's law holds good throughout this range. The authors mention, however, that above 25° these very steady values begin to fall off, and would probably fall to unity below 100°—a result that might be explained by the presence of hydrates which began to dissociate only above 25°. As showing the permanence of the conditions it is stated that one cell, not specially selected, was kept for 60 days without showing any solution-leak or any measurable loss of rotatory power; the osmotic pressure at the beginning was 12·522 atmos. (atmospheric pressure 1·013), and at the end 12·522 (atmospheric pressure 1·016). The extreme range of osmotic pressure was 12·517 to 12·552 = 0·035 atmo., whilst the range of atmospheric pressure was 1·0175 − 0·986 = 0·315 atmo., the fluctuations being in contrary directions, because the cell-pressure can only alter slowly as water flows through the membrane. The conventional criticism of semi-permeable membranes as ideals which can never be realised in practice is now obviously absurd. Nickel ferrocyanide has been used in place of the copper salt, and serves equally well. [See also Abstract No. 1066 (1911).] T. M. L.

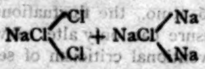
1277. *Volume of a Solute in Solution, II. Influences of Molecular Association, Solvate Formation, and Ionisation.* **D. Tyrer.** (Chem. Soc., Journ. 99. pp. 871–880, May, 1911.)—From measurements made with a considerable number of solutions of different types the author concludes that (1) in solutions in which no chemical changes of any kind occur, the specific volume of the solute is constant, independent of the concentration, but its value varies slightly for different solvents. (2) Molecular association of the solute in solution is without influence on the apparent volume of the solute. (3) Combination of the solvent and solute usually causes a contraction in the apparent volume of the solute; the volume of the solute in solution generally decreases with decrease of concentration. (4) Variation of the specific solution volume of a non-electrolyte with variation of the concentration may be regarded as a true criterion of solvate formation; from this it follows that hydrates are formed in almost all aqueous solutions of non-electrolytes. (5) In aqueous solutions of electrolytes it is probable that both the undissociated molecules and the ions are hydrated. T. M. L.

1278. *Decomposition of Water by Metals.* **M. Kernbaum.** (Comptes Rendus, 152. pp. 1668–1670, June 12, 1911.)—The author confirms Traube's observation that hydrogen peroxide is not produced by the interaction of zinc and water in the absence of air or oxygen, but in contradistinction to Traube, finds that hydrogen is formed under these conditions. From a consideration of the above, together with the decomposition of water by the electric current, by β-rays of radium, by heat, &c., the author comes to the conclusion that the decomposition is represented by the equation $H_2O = H^+ + OH^-$, which agrees with the electrolytic dissociation of water. [See Abstracts Nos. 1318, 1319, and 1638 (1909).] T. S. P.

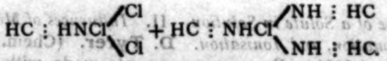
1279. *Processes operative in Solutions: XIX: Complexity of the Phenomena afforded by Solutions: a Retrospect with an Addendum on Non-aqueous Electrolytes.* **H. E. Armstrong.** (Chem. News, 103. pp. 97–99, March 3; and pp. 109–111, March 10, 1911.)—It is impossible in an abstract to do justice to this retrospect, in which the author summarises his views on the nature of solutions as they have been developed during the period from 1885 to the present day; the original paper must be consulted by those who wish to study the subject. In extending his views to non-aqueous electrolytes the author suggests that just as the active material in an aqueous solution of hydrogen chloride is a mixture of—



two kinds of molecules in which solvent and solute in turn become distributed into two radicals, so also in fused salt distribution may take place according to the scheme—



In the case of hydrogen chloride dissolved in hydrogen cyanide the electrolyte is considered to be the salt H . C : NH . Cl distributed according to the scheme—



T. M. L.

1280. *Processes operative in Solutions.* **H. E. Armstrong and D. Crothers.** (Chem. News, 103. pp. 121–122, March 17, and pp. 133–135, March 24, 1911.)—It has been shown previously that the addition of sugars such as glucose does not appreciably affect the rate of hydrolysis of cane-sugar by acids in aqueous solutions, although large "concentrating" effects are produced by salts, and not inconsiderable "depressent" effects by alcohols of the ethylic series. It is believed that this inactivity of the sugars must be due to two opposite effects nearly compensating one another. This view is supported by the experiments now described on the effects of non-electrolytes on the conductivity of salts. This effect is most marked in the case of highly oxygenated substances, and in the case of the polyhydric alcohols the diminution of conductivity is almost proportional to the number of the oxygen atoms. It is noteworthy that alcohols which are of high molecular weight and small solubility in water are most effective, perhaps because they move more freely through the liquid. **T. M. L.**

1281. *Equilibrium between Sodium Carbonate, Sodium Bi-Carbonate, and Water.* **H. N. McCoy and C. D. Test.** (Amer. Chem. Soc., Journ. 33. pp. 473–476, April, 1911.)—The curve showing the concentrations of saturated solutions of sodium carbonate and bicarbonate includes the following points :—

	Gm. of Bicarbonate per Litre.	Gm. of Carbonate per Litre.
A	98·7	0·0
B	50·8	216·6
C	27·6	276·3
D	0·0	276·4

From A to B the solution is saturated with bicarbonate, and from C to D with carbonate ; from B to C the solid phase is the sesquicarbonate—

$$Na_2CO_3, NaHCO_3, 2H2O,$$

identical with the mineral "trona"; an artificial method of making this compound is described. **T. M. L.**

1282. *Binary System of Cuprous and Potassium Bromides.* **P. De Cesaris.** (Accad. Lincei, Atti, 20. pp. 749–751, May 21, 1911.)—The melting-point of mixtures of KBr and CuBr falls steadily with increasing proportion of CuBr, from 780°, the melting-point of KBr, to 182° for a mixture containing about 88 per cent. KBr. Further increase in the proportion of CuBr again raises the melting-point, which finally, for pure CuBr, reaches 480°. The max. retardation of crystallisation occurs for a mixture melting at 284°, which corresponds in composition to the formula CuBr,2KBr. W. H. Si.

1283. *Causes of Internal Pressure in Liquids.* **V. Polowzow.** (Zeitschr. Phys. Chem. 75. 5. pp. 518–526, 1910.)—In order to test the views of Tammann and of Nernst as to the origin of internal pressure in liquids, experiments were made on three types of dissociable compounds. (1) Chloracetic acid undergoing ionisation in aqueous solutions was found to contract to the extent of 10 c.cm. for each gm.-mol. ionised. (2) But alcohol dissociating in benzene from mol. wt. 284 to mol. wt. 46 (concentration 4·56 to 0·08 gm.-mol. per litre) showed an *increase* of volume of about 2 c.cm. (3) So also amyl acetate when compared with a mixture of amylene and acetic acid was found to have a smaller volume both in the liquid state (contraction 12·15 c.cm.) and when dissolved in benzene (contraction 12·26 c.cm.). The conclusion is drawn that internal pressure is increased by a dissociating solute only when the dissociation results in the production of oppositely-charged products. T. M. L.

1284. *Theory of the Chemical Action of the Electric Discharge in Electrolytic Gas.* **P. J. Kirkby.** (Roy. Soc., Proc. Ser. A. 85. pp. 151–174, May 10, 1911.)—Further experiments have been carried out to test the theory suggested by earlier results [see Abstracts Nos. 1268 (1905), 1248 (1907)] and with the object of providing data for developing it. The author gives the following summary of conclusions: (1) When a steady discharge passes through electrolytic gas at pressure p mm., the number of molecules of water-vapour formed by the passage of the atomic charge through 1 cm. of the positive column, where the electric force is Y, is approximately $7{\cdot}9pe^{-427p/Y}$. This number, which is independent of the current, appears to be absolute (*i.e.*, independent of the apparatus and not confined to positive columns) and to depend only upon the field of force. (2) The atoms of oxygen, when separated, are not charged electrically. This is proved by experiments independently of theory. Hence the atom of oxygen is not bound in a molecule of water-vapour by electrostatic force. (3) The chemical effects, within the positive column, are due to the collisions of the (corpuscular) negative ions with the oxygen molecules, which are dissociated into atoms, under certain conditions, by those collisions, and so enabled to combine with hydrogen. (4) The energy of formation of an oxygen molecule is less than $6{\cdot}1 \times 10^{-12}$ ergs, and is nearly equal to $5{\cdot}8 \times 10^{-12}$ ergs. (5) Water-vapour is produced by the collision of an atom of oxygen with a *molecule* of hydrogen. (6) The energy of formation of a molecule of water-vapour is nearly $6{\cdot}4 \times 10^{-12}$ ergs. (7) Only half the collisions that an electron makes with a molecule of oxygen, with sufficient velocity to dissociate it, succeed in doing so. L. H. W.

1285. *Load Capacity of Galvanic Elements.* **I. D. Reichinstein.** (Zeitschr. Elektrochem. 17. pp. 85–90, Feb. 1, 1911.)—With the oscillograph arrangement of previous experiments [see Abstracts Nos. 291, 758 (1910), and 427 (1911)] the author studies the differences in the potentials of electrodes on closed and on open circuit. The cell is a glass-beaker containing, in a porous pot, an auxiliary PbO_2-electrode of large surface, 290 cm.^{2}, and the chief electrode (under examination), a foil of metal which is all paraffined except 5 cm.^{2} facing the peroxide plate. Between the two electrodes is a Witt stirrer, upon whose speed the potential depended; but when the stirrer was turned 800 times per min., a further increase in the speed did not any longer affect the potential. In experimenting with a copper foil in N/1-$CuSO_4$ the potential dropped at once by 0·817 volt when the circuit was closed with a current of 0·188 amp. (per 5 cm.^{2}). This drop is many times too large to be ascribed to a concentration polarisation, *i.e.*, to an increase of the copper ions at the copper electrode. The drop became less marked when the experiment was repeated several times, and much less strong when sulphuric acid was added to the sulphate. In similar experiments, nickel in sulphuric acid (in which it might be active or passive) gave a still greater drop, and observations on zinc in Na_2SO_4 also tend to show, that the current generation is caused by different chemical processes at different current densities, though the final products are the same. The author further discusses the kathodic deposition of metals in the sense of Freundlich's views on the velocity of crystallisation, and describes experiments on the solution of Pt in cells: Pt/H_2SO_4/KI, I/Pt, the circuit containing two current interrupters. With intermittent currents each impulse generates some platinum oxide and some oxygen on the surface of the Pt, and the short-circuiting sweeps this layer of oxygen-alloy away. When the current remains uninterrupted, this layer is not disturbed, and the Pt is hardly attacked. H. B.

1286. *E.M.F. due to Flow through a Capillary Tube.* **L. Riéty.** (Comptes Rendus, 152. pp. 1875–1876, May 22, 1911.)—Quincke observed in 1859 a p.d. between the parts of a badly conducting liquid (water, alcohol) entering and leaving a capillary tube. Gouré de Villemontée did not observe any p.d. when applying salt solutions and pressures up to 8 atmos. With solution of copper sulphate containing 10 gm. of sulphate per litre, the author finds an e.m.f. of 0·08 volt when the pressure is raised to 90 atmos. The p.d. increases directly as the pressure, as it should according to Poiseuille, and diminishes when the concentration is raised. The potential is higher at the electrode placed at the exit of the liquid than at the other electrode, indicating that the positive electricity is transported in the direction of the liquid current. H. B

1287. *Temperature-coefficient of Concentration Cells in which the same Salt is dissolved in two different Solvents.* **A. P. Laurie.** (Roy. Soc. Edinburgh, Proc. 31. pp. 375–396, 1910–1911.)—The cells used contained potassium iodide and iodine dissolved in water and in alcohol. The influence of temperature was determined and with the help of the temperature-coefficients the e.m.f.'s were calculated from the latent heats of solution. It was shown that the condition of equilibrium in the potassium iodide-water-alcohol cell is not when both solutions are saturated with the salt, but when the strength of the water-solution is such that when in contact with alcohol saturated with KI diffusion produces no salt precipitation. This equilibrium is reached when the strength of the water solution is about 2 mols. of KI per 1000 c.cm. T. M. L.

1288. *Elimination of Liquid Potentials in measuring Electrode Potentials.* **N. Bjerrum.** (Zeitschr. Elektrochem. 17. pp. 389–398, May 15, 1911.)—The author shows theoretically and by new experiments on cells containing HCl, KCl, NaCl, which he makes in conjunction with Miss J. Bjerrum, that the diffusion potentials between diluted aqueous solutions can very well be eliminated by interposing saturated or half-saturated solution (3·5 or 1·75-N.) of potassium chloride, provided the extrapolation involved be about 0·5 millivolt, or do not, at any rate, come up to 2 millivolts. The ammonium nitrate which Abegg and Cumming recommended [see Abstract No. 548 (1907)] appears less suitable. Compare also Abstract No. 485 (1911) as to the formulæ of Planck, Henderson, and Nernst. H. B.

1289. *Electrolytic Valve Action in Fused Salts.* **G. Schulze.** (Zeitschr. Elektrochem. 17. pp. 509–514, July, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—According to the author [see Abstracts Nos. 1019 (1908) and 971 (1911)] a valve action should result, whenever the anode is insoluble in the electrolyte, and when it covers itself with a non-conducting film while liberating gas. It was hence to be expected that fused salts would be suitable for electrolytic valve cells, as their solvent power is small. This is confirmed for anodes of tantalum and of aluminium in salts, all melting below 500° C., nitrates, chromates, sodium formate, caustic soda; no valve effect was observed in (KCl + LiCl) $HgCl_2$, $BiBr_3$, CdI_2. The max. voltage which is stopped by the fused salts lies in all cases below the minimum value found in the respective aqueous solutions, which generally are less effective at 100° C. than at 0° C. The velocity of formation decreases in the fused salts when the temperature is raised. Aluminium stops nearly as high voltages as tantalum, but it is exceedingly sensitive to traces of water; the one limb of the H-vessel used for the experiments was hence charged with P_2O_5. The author estimates the degree of dissociation in the fused salts under the assumption that the max. voltage cut off will essentially depend upon the concentration of the ions. H. B.

1290. *Corrosion of some Metals in Sodium Trinitride Solution.* **J. W. Turrentine.** (Amer. Chem. Soc., Journ. 33. pp. 803–828, June, 1911.)—The results obtained are summarised by the author as follows: (1) Among the ten metals studied, Mg, Al, Zn, and Cd, in 3 per cent. NaN_3 solution, and Ag in very dilute hydronitric acid solution, give anode efficiencies exceeding 100 per cent. of the corrosion predicted by Faraday's law. (2) To account for the excessive anode efficiency the assumption is made that these metals dissolve electrochemically, partially at least, at a valence lower than that usually ascribed to them, forming compounds which are readily oxidised. (3) In support of this hypothesis, reduction products of the N_3 ion, such as ammonia, hydrazine and nitrogen, are formed in the anode region, indicating the production there of some reducing agent. (4) A new reduction of hydronitric acid is supposed which involves the formation of free nitrogen in addition to ammonia, or ammonia and hydrazine, as the reduction products. (5) The metals, Ni and Pb, become passive in unstirred solution, while Al, Fe, Ni, Sn, Pb, and Ag become passive, or practically so, in stirred solution. L. H. W.

1291. *Electrolytic Chromium.* **J. Voisin.** (Rev. de Métallurgie, 17. p. 1137, 1910. Metallurgie, 8. pp. 344–346, June 8, 1911.)—The author tests old methods and tries new ones, making use of a chromium anode. The Cr, gained with the aid of thermit, is more valuable for this purpose than the metal from the electric furnace, because the latter contains carbon, and some Cr sinks to the bottom with the carbon. Solution of sesquioxide in hydrofluoric acid gave no metal, but only a green deposit (a hydrate) on the kathode. Solution of the metal in hydrochloric acid did not answer either. In sulphuric acid the metal is not soluble. But the electrolysis succeeds in a U-tube containing sulphuric acid into which chromium acetate is introduced, while CO_2 is passed through the electrolyte, with currents of 7 amps. and 10 volts, an anode of Cr and a kathode of Pt or graphite. The good deposit of Cr turns grainy when the electrolysis is prolonged, and may finally contain chromium acetate. H. B.

1292. *Electrolytic Copper free from Arsenic.* **Ching Yu Wen.** (Metallurgical and Chem. Engin. 9. pp. 318–319, June, 1911. Dissertation, Columbia Univ., New York.)—The author studies the deposition of copper free from As and Sb and the tree-formation in four kinds of electrolytes: (1) Impure sulphate without additions; (2) the same sulphate with inorganic; (3) with organic additions; (4) with both inorganic and organic additions. In (1) As and Sb deposit when the bath contains 1·5 per cent. of As. But when the As content exceeds 6 per cent. and the temperature 50 or 60° C., the As acts as addition-agent, preventing the deposition of As, possibly because $As_2(SO_4)_3$ is hydrolysed into arsenious acid (which would not wander to the kathode) and sulphuric acid; at 40° C. the As-content must be 8 per cent. to have this preventive effect. (2) Sodium chloride, less so hydrochloric acid and sodium sulphate, improve the deposits; aluminium chloride does not; aluminium sulphate does partly, again at certain concentrations and at 40° C. (3) Both gelatine and tannin are advantageous (although gelatine first favours a certain amount of tree-formation), not peptones. (4) The best success was obtained with 0·01 or 0·02 per cent. of both gelatine and of NaCl. According to **E. F. Kern,** under whom the author worked, the effect of the salts would be due to their metallic ions. H. B.

1293. *Polarisation in its Relation to the Decomposition Pressure of Electrolytes.* **O. P. Watts.** (Amer. Electrochem. Soc., Trans. 19. pp. 91–106; Discussion, pp. 106–108, 1911.)—The author shows by data of the electrolysis of sodium chloride (carbon electrodes), normal or acid copper sulphate (electrodes of Pt or of Cu), and zinc bromide (carbon electrodes), that in cases, when the flow of current is not in accordance with Ohm's law, a counter e.m.f. (traced to changes produced in the materials of the electrodes and of the electrolyte in contact with them by the passage of the current) nullifies the impressed e.m.f. and causes the phenomenon of the decomposition voltage. H. B.

1294. *Electrolytic Refining of Iron.* **C. F. Burgess.** (Amer. Electrochem. Soc., Trans. 19. pp. 181–183; Discussion, pp. 183–184, 1911.)—Anodes of the best commercial iron gave an iron of 99·97 per cent., when electrolysed in solutions of 40 gm. of ferro-sulphate with 40 cm. of ammonium chloride per litre by currents of 1 volt and 6 to 10 amps. per sq. ft. The bath was run continuously for months; it was kept still, being circulated through a series of tanks once a week only; iron chloride did not answer so well. H. B.

1295. *Electrolytic Formation of Chlorate and Current Concentration.* **E. Müller and P. Koppe.** (Zeitschr. Elektrochem. 17. pp. 421–430, June 1, 1911.)—According to F. Foerster and E. Müller the electrolysis of neutral alkali chloride without diaphragm yields in the first instance hypochlorite, and in the second instance anodically chlorate, while oxygen is liberated, which means a waste of electric energy. When, however, the electrolyte is acidulated with hydrochloric acid so as to raise the ratio HClO/NaClO, chlorate is produced chemically without evolution of oxygen. The authors now show theoretically and by experiments, that the reduction of the current concentration has the same beneficial effect as the increase of the just-mentioned ratio. By current concentration they understand the ratio (current intensity)/(volume of electrolyte). It is more advisable to work with large volume and small acidulation than *vice versâ*, because in the former case high efficiency can be obtained without any evolution of Cl. The experiments were made with a 20 per cent. solution of NaCl to which 0·2 per cent. of K_2CrO_4 was added. H. B.

1296. *Electrolysis of Hot Alkali Chloride Solutions.* **R. Sacerdoti.** (Zeitschr. Elektrochem. 17. pp. 473–478, June 15, 1911.)—The arrangement of the cell resembles that of Russ [see Abstracts Nos. 2068 and 2071 (1904)]. The beaker is covered with wood soaked in paraffin, and the cell fixed in it is divided by a clay diaphragm. The electrodes are discs of Pt, magnetite, or iron, smooth or polished; the Pt is fused into glass, leaving only a free front, the magnetite fused into a glass tube filled with mercury. A special Pt electrode, joined to an alternating-current source serves for heating the electrolyte up to 97° C. Potentials are measured after Luggin-Haber with the aid of a capillary syphon and a decinormal calomel electrode. The current intensity is raised and lowered again with the aid of resistance so that a series of observations can be taken within a few minutes. The kathode potential is little influenced by the temperature. The anode potential can be lowered by 0·8 volt, so that practically the bath potential (electrode polarisation *plus* fall of potential in electrolyte) would be $(1{\cdot}8 + 0{\cdot}8) = 2{\cdot}1$ volts with a strongly alkaline katholyte. H. B.

1297. *Contribution to the Study of Electrostenolysis.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 35. 2. pp. 182–189, 1910–1911.)—The author has studied the phenomena of electrostenolysis at comparatively low voltages. The apparatus used consisted of a glass tube which had been sealed at the lower end and then cracked by quenching; it contained the solution under investigation and was immersed in more of the same solution. The kathode was contained in the tube. With a fresh solution of ferrous sulphate, and voltages gradually increasing from 0 to 100 volts, electrostenolysis occurred, as shown by the readings of a galvanometer in circuit becoming unsteady, at 84, 95, and 108 volts respectively with three different tubes. Direct observation, however, was found to be preferable to galvanometer readings. Using a solution of silver nitrate, it was shown: (1) that electrostenolysis is not affected by electric waves; (2) that with the same tube the voltage at which electrostenolysis occurs is always much greater at the first test than at the succeeding ones; (3) that the critical voltage varies greatly with different tubes, but it is independent of the size of the aperture (crack); (4) that there is no relation between the critical voltage and the concentration of the solution, which varied from 0·02–1 per cent. When two tubes were used, the one containing the kathode and the other the anode, and both immersed in the solution, the critical voltage was approximately additive. The metallic deposit formed on the exterior of the tube containing the kathode and on the interior of the other tube. With a solution of silver nitrate in ethyl alcohol of density 0·8174, electrostenolysis does not occur at 110 volts; when mixed with an equal volume of water there is a feeble effect, which increases as the proportion of water is increased. In acetone solution ordinary electrolysis occurs, but no electrostenolysis. An aqueous solution of lead acetate shows the phenomenon in question at 90 volts, but the solution in ethyl alcohol (sp. gr. = 0·8174) does not, unless previously exposed to the air for 24 hours, whereby water is absorbed. In the light of the above results the author discusses the various theories of electrostenolysis, and favours that of Coehn. T. S. P.

1298. *Electrolytic Furnace Method for Metal Reduction.* **J. W. Beckman.** (Amer. Electrochem. Soc., Trans. 19. pp. 171–175; Discussion and Communications, pp. 175–180, 1911. Chem. News, 104. pp. 45–46, July 28, 1911.)—The author claims, in very general terms, to be able to reduce mixtures of CaO with oxides (or sulphides) such as $CaO.Fe_2O_3$. This mixture is not itself decomposed by the current when fused; but iron is deposited and oxygen generated when more oxide is added to the bath. In this way he produces manganese, tungsten, and vanadium, not free from carbon so far. He refers to his U.S. Pat. No. 978,336. According to **C. A. Hansen** the reduction might merely be due to carbon at the high temperature of about 1500° C.; **W. F. Bleecker** and **C. Hering** commented more favourably on the experiments. H. B.

REFERENCES.

1299. *Measurement of Infinitesimal Quantities of Matter.* **W. Ramsay.** (Journ. de Physique, 1. Ser. 5. pp. 429–442, June, 1911. Paper read before the Soc. franç. de Physique, April 20, 1911.)—Largely a summary of papers already published by the author and R. W. Gray in other journals on the properties of RaEm or "niton" [Abstracts Nos. 1684 (1909), and 1520 and 1768 (1910)]. The weight of helium formed by niton during transformation into radium A, B, C, and D from July to Oct. has been measured, and amounted to 27 millionths of a mgm. W. H. Sl.

1300. *Critical Temperature, Boiling-point, and Expansion Coefficient of Phosphorus Pentachloride.* **E. B. R. Prideaux.** (Faraday Soc., Trans. 6. pp. 155–159, Feb., 1911.)

1301. *Electron Theory of Metallic Mixed Crystals.* **A. L. Bernoulli.** (Ann. d. Physik, 35. 1. pp. 162–170, June 2, 1911.)

1302. *Critical Phenomena in Solutions under the Ultramicroscope.* **W. v. Lepkowski.** (Zeitschr. Phys. Chem. 75. 5. pp. 608–614, 1910.)—The opalescence of a mixture of amylene and aniline when cooled to the point at which they cease to be miscible was shown to be due to the actual production of small drops. T. M. L.